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BIOMEDICAL AND BEHAVIORAL SCIENCES

No. 116

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REGARDING DIFFERENCES IN THE RESPIRATION OF LEAVES OF SPRING AND WINTER WHEAT

Moscow ZHURNAL OBSHCHEY BIOLOGII in Russian No 3, 1979 pp 442-447

[Article by L. P. Chel'tsova, N. I. Lebedeva, the All-Union Scientific Research Institute of Applied Molecular Biology and Genetics, Moscow. The article was received at the editorial office 27 September 1977]

[Text] On a Warburg apparatus we studied the intensity of absorption of oxygen, as well as its stimulation under the influence of 2-4 dinitrophenol (DNP) on the leaves of plants of spring and winter sorts of wheat during spring and fall sowing. It was shown that in winter wheat, which was significantly delayed in development, the absorption of oxygen, as well as its stimulation under the influence of DNP was not lower than with the rapidly developing spring wheat. Its content of high-energy compounds was also high. This points to the high energetic effectiveness of respiration. An assumption was made about the fact that the causes of the delay of development of the winter wheat does not lie in an insufficiency of energy.

Physiological differences between spring and winter varieties of wheat in various aspects were considered by many authors. However, up to the present time the question concerning mechanisms to which the property of "springness" and "winteriness" of the wheat is linked remains unsolved. Why, upon spring sowing with unvernallized seeds, spring wheat bears ears and gives a yield while winter wheat, not having undergone vernalization, is delayed for a protracted period in a vegetative condition (in the tillering phase) and does not proceed to the next phase (emergence into the tubular stage)--which is the beginning of generative development--is unclear. One of the possible causes of this might be a shortage of energy necessary for the processes of synthesis. However, in the literature there is little data on this question.

It is well known that both in spring wheat and in winter wheat which have undergone vernalization, in the beginning of the phase of emergence into the tubular stage the intensiveness of respiration rises sharply (Gunar, Krastina, 1952; Bagdykov, 1954; Babenko, Sivolap, 1972). At the same time in winter wheat from spring planting with unvernallized seeds, when they are delayed in the tillering phase, the intensiveness of respiration significantly decreases in comparison with spring wheat (Bagdykov, 1954; Rubin, Sokolova, 1954). Upon emergence of wheat plants in the tubular stage an elevated content of organic phosphate and high energy phosphate compounds is noted in their leaves (Kazanskaya, 1960; Babenko, Sivolap, 1972; Sivolap, 1974). However, the available data are inadequate and do not give an answer to the following questions: Is the respiration of spring and winter wheat which have undergone vernalization more energetically effective than the respiration of unvernallized winter wheat delayed in development; are the former capable of greater production of high energy phosphorus than the latter?

The present communication is devoted to these questions. Regarding the energetic effectiveness of respiration we judged by the stimulation of its intensiveness under the influence of 2-4 dinitrophenol (DNP), which makes it possible to talk either about the presence of conjugation of oxidation with phosphorylation or about the change of the interrelationships between these processes (Semikhatova, 1967; Semikhatova, Yudina, 1968; Eydel'vant, Demurina, 1970). The determinations were carried out on intact tissues, which allowed us to create conditions more similar to natural ones, taking into account the regulatory activity of cells (Semikhatova, 1966; Gordon, Bichurina, 1968). For a fuller description of the energy reserve we determined the quantity of high energy labile phosphates of nucleotides which made it possible to judge regarding the phosphate energetic potential of tissue (Semikhatova, 1974).

Materials and Methods

We carried out the work on the spring wheat "Saratovskaya 29" and on winter wheats "Mironovskaya 808," "Lyutetsens 329," and "Ul'yanovka." The seeds were sown in spring at the optimal time for spring wheat and in the fall at the optimal times for winter wheat. In each sample for analysis we selected plants which had attained one phase of development, having an identical number of leaves and an identical height.

We determined the intensiveness of respiration of leaf tissues in a thrice repeated test of the absorption of oxygen in a Warburg apparatus at 25°C. We carried out the reading after 30 min. We judged regarding the energetic effectiveness of respiration (EER) by the influence on its intensiveness of DNP infiltrated into the tissues at a concentration of $10^{-4}M$, which on our object in the majority of cases gave the greatest stimulation of respiration. Leaves infiltrated with distilled water neutralized with soda served as a control.

We carried out the extraction of phosphorus compounds from fresh tissue with perchloric acid (5 percent). We concentrated the nucleotides on activated charcoal (Marre, Forti, 1958) from which after 10 minutes of hydrolysis with 1N hydrochloric acid we isolated the labile nucleotides (Kazuto, Tuyeva, 1966). The determination of the content of phosphorus in the solution was carried out by the Denizhe method with the use of stannous chloride.

Results of the Investigations

The intensiveness of respiration of leaves, like the stimulation of respiration under the influence of DNP fluctuates significantly in various years, which is linked with the influence of weather conditions. Thus, the fall of 1973 was colder than 1974, and respiration was more intense (Figure 1).

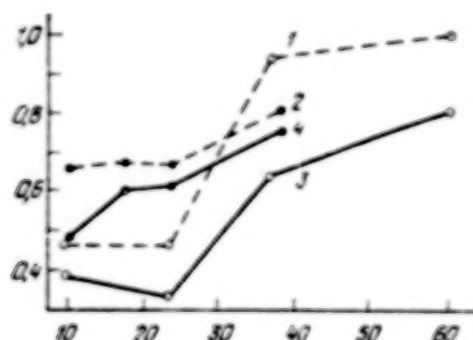


Figure 1. The absorption of oxygen by tissues of leaves of the winter wheat "Ul'yanovka" with the infiltration of water (3, 4) and DNP $10^{-4}M$ (1, 2) in 1973 (2, 4) and 1974 (1, 3). The abscissa--the number of days after sprouts, ordinate--the absorption of oxygen, ml·hr/g fresh weight of tissue.

A comparison of data obtained on plants of spring and fall sowing shows that in separate years in spring the intensiveness of respiration and its stimulation may be roughly the same as in the fall. This is revealed in those cases when spring is comparatively cold and fall is warm. Therefore, it is necessary to compare data over a number of years. Moreover, the intensiveness of respiration depends on the phase of development, and one can only compare those samples in which plants of one size were used which had attained one and the same phase of development. In conjunction with this, in order to sum up the results obtained, averaged data over the period 1973-1976 were taken into account. Mainly not the age of the plant was taken into account, but the phase of development. Such an analysis allowed us to obtain more comparable data.

In the ontogenesis both of spring and winter wheat a rhythmical change of the intensiveness of respiration is observed with periods of rise and fall. In spring wheat and wheat which has wintered, that is winter wheat which has undergone vernalization with transition to the phase of emergence in the tubular stage (at the end of the tillering stage, beginning of the stage of emergence in tubular form) a rise of the intensiveness of respiration was observed, as this is already described in the literature.

With the infiltration of water into the tissues the intensiveness of absorption of oxygen, although it is lower than in uninfiltrated leaves, still remains high (Table 1). In the beginning of the emergence into the tubular stage it intensifies. Simultaneously the stimulation of respiration under the influence of DNP decreases. It increases later, when the intensiveness of respiration falls.

Table 1. The Absorption of Oxygen by the Tissue of Leaves of "Saratovskaya 29," Infiltrated With Water, and Its Stimulation Under the Influence of DNP

(1) Фаза развития растений или время посева	(2) Поглощение кислорода ($\mu\text{л}\cdot\text{ч}/\text{г}$ свежего веса) при севе		(3) Стимуляция дыхания под влиянием ДНП (% от контроля) при севе	
	весной (4)	осенью (5)	весной (4)	осенью (5)
(6) Два листа	309	377	144	117
(7) Три листа	396	391	131	117
(8) Начало кущения	334	329	135	133
(9) Кущение	392	450	127	119
(10) Выход в трубку	553	672	109	106
(11) То же	226	659	150	104
"	—	473	—	143

Key:

1. Phase of development of plants at the time of taking the samples
2. The absorption of oxygen ($\mu\text{л}\cdot\text{ч}/\text{г}$ fresh weight) at sowing
3. The stimulation of respiration under the influence of DNP (% of control) at sowing
4. Spring
5. Fall
6. Two leaves
7. Three leaves
8. The beginning of tillering
9. Tillering
10. Emergence into the tubular stage
11. The same

A similar picture is observed in winter wheat, too, at the time of spring growth before the beginning of the phase of emergence into tubular form: the intensiveness of absorption of oxygen is usually high (373–698 $\mu\text{л}\cdot\text{ч}/\text{г}$ of fresh weight), and stimulation of it with DNP is comparatively low

(105-120 percent). Lesser stimulation of respiration under the influence of DNP with an increase of its intensiveness witnesses to the lesser conjugation of phosphorylation and oxidation, that is to the lesser formation in this moment of ATP. This does not point to lesser provision with energy of cells or to lesser content in them of ATP. The latter can be stored earlier. Therefore the increased content of high energy phosphorus, revealed in tissues at the period of emergence into the tubular stage, can be explained by its accumulation in the preceding period. Moreover, the cell can use energy obtained not only at the expense of the hydrolysis of ATP. Other sources of energy supply exist.

Upon sowing spring wheat in the fall its growth and development proceeds at a slower tempo. At the same time the same rhythm of change in the intensiveness of respiration is roughly conserved; however, periods of its rise and fall are more stretched out. In the beginning of the phase of emergence into the tubular form is noted also an increase in the intensiveness of absorption of oxygen and its lesser stimulation under the influence of DNP. A comparison of the data obtained upon analysis of the plants of spring and fall sowing (Table 1) carried out, taking into account the phase of development, shows that the intensiveness of absorption of oxygen in fall conditions with a delay of growth and development is higher in the majority of samples than in the spring. However, this difference often is not reliable. Stimulation of the intensiveness of absorption of oxygen under the influence of DNP in the fall is lower than in the spring, or roughly so.

Upon comparing winter wheat from the sowing of unvernallized seeds in the spring and fall the same regularity is observed: in the fall the intensiveness of absorption of oxygen is higher than in the spring, and its stimulation under the influence of DNP is lower (Tables 2, 3). These differences in a majority of cases are reliable. Toward the end of fall with hardening off of plants the conjugation of oxidation and phosphorylation usually is elevated, which agrees with data from the literature (Usova, Borzhkovskaya, 1970; Karmanenko, 1972; Khisamutdinova and coauthors, 1972).

In our experiments the measurement of the intensiveness of absorption of oxygen in all cases was carried out at 25°C, and not at that temperature which existed on the plot of land at the given period. Therefore it is natural that the data cited in Tables 2 and 3 do not characterize the real intensiveness of respiration which is observed in the field (in the fall with a decrease of temperature the intensiveness of respiration decreases). These data rather reflect the changes taking place in the respiratory system, its state in plants from the spring and fall sowing.

Table 2. Absorption of Oxygen by the Tissue of Leaves, Infiltrated with Water in Plants Grown From Unvernalized Seeds ($\mu\text{l}\cdot\text{hr/g}$ of fresh weight)

(1) Сорт	(2) Время проведения опыта и НСР ₀₅	(3) Фаза развития растений во время взятия пробы			
		(4) два листа	(5) три листа	(6) начало кущения	(7) середина кущения
(8) Саратовская 29	Весна (11)	309	396	334	—
	Осень (12)	377	391	386	—
	НСР ₀₅	30.2*	106.0	63.7	—
(9) Мировская 808	Весна	302	240	351	307
	Осень	478	477	476	707
	НСР ₀₅	61.1*	90.8*	54.6*	98.4*
(10) Ульяновка	Весна	380	248	319	394
	Осень	491	469	486	673
	НСР ₀₅	70.5*	155.9*	79.4*	91.9*

*Differences are reliable at the 5 percent level of significance.

Note. НСР₀₅—the least essential difference for the 5 percent level of significance.

Key:

- | | |
|--|---------------------------|
| 1. Sort | 6. Beginning of tillering |
| 2. Time of carrying out the sowing and НСР ₀₅ | 7. Middle of tillering |
| 3. Phase of development of a plant at the time of taking of a sample | 8. "Saratovskaya 29" |
| 4. Two leaves | 9. "Mironovskaya 808" |
| 5. Three leaves | 10. "Ul'yanovka" |
| | 11. Spring |
| | 12. Fall |

In the fall the delay of growth and development of plants is explained by the decreasing length of the day and the decreased temperature under whose influence physiological processes linked with growth are inhibited. However in this period plants pass through vernalization, prepare themselves for the following spring vegetation. It is difficult to distinguish the processes linked with fall delay, promoting preparation for winter and processes linked with the preparation for spring activation of growth.

Upon sowing winter wheat in spring with unvernalized seeds in conditions favorable for growth, an intensive growth of plants is observed, but with a significant delay in their development: plants find themselves in the phase of tillering and do not emerge into the tubular stage for a long period. During this delay is observed a relatively high intensiveness of respiration, a high velocity of oxidation ($200\text{--}400 \mu\text{l}\cdot\text{hr/g}$ of fresh weight) and a significantly greater stimulation under the influence of DNP than in the fall, that is, a greater conjugation of oxidation and phosphorylation.

Table 3. Stimulation of Absorption of Oxygen by Tissue of Leaves Infiltrated by DNP in Comparison With the Absorption of Oxygen by Tissue of Leaves Infiltrated With Water (Taken as 100 Percent) in Plants Grown From Unvernalized Seeds, Percent

(1) Сорт	(2) Время проведе- ния опыта и HCP ₀₅	(3) Фаза развития растений во время взятия пробы			
		(4) два листа	(5) три листа	(6) начало кущения	(7) середина кущения
(8) Саратовская 29	Весна (11)	144	131	135	—
	Осень (12)	117	117	126	—
	HCP ₀₅	11,4*	29,6	27,6	—
(9) Мироновская 808	Весна	142	156	135	153
	Осень	119	109	117	136
	HCP ₀₅	35,0	6,3*	10,8*	37,8
(10) Ульяновка	Весна	172	142	141	145
	Осень	113	114	123	130
	HCP ₀₅	35,7*	11,4*	11,8*	12,4*

*Differences are reliable at the 5 percent level of significance.

Key:

- | | |
|--|---------------------------|
| 1. Sort | 6. Beginning of tillering |
| 2. Time of carrying out the sowing and HCP ₀₅ | 7. Middle of tillering |
| 3. Phase of development of a plant at the time of taking of a sample | 8. "Saratovskaya 29" |
| 4. Two leaves | 9. "Mironovskaya 808" |
| 5. Three leaves | 10. "Ul'yanovka" |
| | 11. Spring |
| | 12. Fall |

All this witnesses to the high energy provision of plant tissues, which is also confirmed with data about the content of high-energy compounds. In the spring during the tillering period their rather high content is noted, even higher than in the fall (Table 4). This does not allow us to explain the protracted stay of plants in the tillering phase, the delay of their development, by insufficient provision of energy.

Table 4. The Content of High Energy Phosphorus in Tillering Nodes, $\mu\text{g/g}$ of Dry Substance

Sort	Spring sowing*	Fall sowing	After wintering
"Saratovskaya 29"	25.0-57.1	35.3	--
"Mironovskaya 808"	37.5-46.9	24.0	35.6
"Lyutetsens 329"	55.7-56.5	15.5	45.3
"Ul'yanovka"	69.2-63.3	17.3	62.0

*Note. The data of two experiments.

A comparison in the tillering phase of winter wheat sown in the spring with unvernallized seeds with spring wheat and these same sorts of winter wheat upon spring growth after wintering shows that although the development of the latter goes without delay and they rapidly emerge into the tubular stage, the intensiveness of absorption of oxygen by the tissues of their leaves is roughly the same as in the former, and in a series of cases even lower. Stimulation of the absorption of oxygen under the influence of DNP in them is also not higher. Thus, neither the speed of oxidation, nor its conjugation with phosphorylation in plants of spring wheat and wintered winter wheat is higher, than in winter wheat of the spring sowing. Consequently, the rapid development of the former in comparison with the latter cannot be explained by their capacity for a higher level of formation of high energy compounds. This agrees with the data on determination of the content of phosphorus of labile nucleotides which spring wheat of spring planting and winter wheat in the period of spring growth in the tillering phase contain in not greater and sometimes even in lesser amounts, than the winter wheat of the spring sowing delaying itself in development (Table 4).

The data cited show that the delay of development of winter wheat which has not undergone vernalization is not explained by its lesser ability to produce high energy compounds. However, this is still not an indicator of the fact that the provision of energy of their cells is the same as in the rapidly developing spring wheat or the winter wheat which has undergone vernalization. The plant uses energy not only stored in the guise of phosphorus high-energy compounds, but also its other forms (Skulachev, 1972). The question about the predominance of the use of one or another form of energy and their significance at various stages of ontogeny is only beginning to be elaborated. Investigations in this plane will help us to understand the mechanisms of self-regulation by the plant of the processes of growth and development.

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A METHOD FOR CHOOSING AN OPTIMUM CHARACTERISTIC

Alma-Ata IZVESTIYA AKADEMII NAUK KAZAKHSKOY SSR in Russian No 3, 1979 p 75

[Article by V. A. Antropov, Kazakh SSR Academy of Sciences Institute of Soil Science]

[Text] Choosing the model for the dependence of evaluation criteria on soil properties is difficult in land evaluation because the coefficients of the correlation matrix are close to one another in value.

A matrix analysis method for determining a characteristic close to optimum that is simpler to use than the known statistical methods has been proposed (Rozhkov, 1976).^{*} The table below presents data from correlation analysis of the dependence between some soil properties and a system of yield characteristics for natural vegetation in two natural-climatic zones of Ural'skaya Oblast. Each of these coefficients is based on 60 points.

As we can see, the majority of the coefficients are close in value, and the differences are insignificant. From among these, we must select grass yield characteristics which would be associated most closely with soil properties. For this purpose we marked the two largest coefficients in each column with two asterisks. Thus in the first column the coefficients in the first and third line are marked with two asterisks. We denote this as $(1,3)_1$; the remaining notations are $(2,4)_2$ for the second column, $(2,4)_3$ for the third column, $(1,4)_4$ for the fourth column, $(3,4)_5$ for the fifth column, and $(1,2)_6$ for the sixth column. By simple counting of the numbers within the parentheses, we find that a number appears in line four the greatest number of times--four. For control purposes we add the next highest coefficient in each column, marked with one asterisk. When we examine the combinations of three values-- $(1,3,4)_1$, $(2,3,4)_2$, $(2,3,4)_3$, $(1,2,4)_4$, $(1,3,4)_5$, and $(1,2,4)_6$ --we find that line four enters into all combinations. Consequently the grass yield given in feed protein units has the closest correlation with soil properties, and it may be said to be close to optimum.

^{*} Rozhkov, V. A., "Algoritmy i programmy ob'yektivnoy klassifikatsii pochn na EVM 'Mir-2'" (Mir-2 Computer Algorithms and Programs for Objective Soil Classification), Moscow, 1976.

Matrix of the Coefficients of Correlation Between
Some Soil Properties and Grass Yield Characteristics

(1) Урожай	Пустынно-степная зона (2)			Пустынная зона (6)		
	(3) Мощ- ность почвы (A+B)	(4) Запасы гумуса в A+B	(5) Запасы гумуса в 0-50 см	(3) Мощ- ность почвы (A+B)	(4) Запасы гумуса в A+B	(5) Запасы гумуса в 0-50 см
(7) Биологический	0,83	0,67	0,72	0,81	0,92	0,75
(8) В кормовых единицах	0,26	0,83	0,85	0,73	0,84	0,75
(9) В переваримом протеине	0,72	0,71	0,76	0,70	0,93	0,69
(10) В кормо-протеиновых еди- ницах	0,63	0,80	0,82	0,75	0,94	0,74

Key:

- | | |
|------------------------------------|---------------------------|
| 1. Yield | 6. Desert zone |
| 2. Desert-steppe zone | 7. Biological |
| 3. Soil thickness (A + B) | 8. In feed units |
| 4. Humus reserves in A + B | 9. In digestible protein |
| 5. Humus reserves in 0-50 cm layer | 10. In feed protein units |

Soil properties are analyzed similarly. The only difference is that the combinations are composed in relation to lines rather than columns. As an example the highest coefficients of line one are in the fourth and fifth columns; for the remaining lines, the notations are (2,3)₂, (3,5)₃, and (3,5)₄. The characteristics in the third and fifth columns are ambiguous inasmuch as they fall into the combinations an identical number of times. Introducing one more coefficient to make a combination of three, we get (4,5,6)₁, (2,3,5)₂, (1,3,5)₃, and (2,3,5)₄. Computations show that the humus reserve in soil horizons A+B (the second and fifth columns) exists in the larger number of combinations and that it should be regarded as closer to optimum than all other characteristics.

Thus we find in our evaluation of the soil that the optimum characteristic is the yield of natural vegetation expressed in feed protein units, and that the humus layer of soil horizons A+B should be used for determination of the soil's properties.

This method can also be used for comparative description of different methods of analysis associated with statistical treatment of field data.

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CONFERENCES

DEVELOPMENT OF THE GENETIC AND PHYSIOLOGICAL-BIOCHEMICAL BASES FOR FORMATION OF HIGH-QUALITY GRAINS. NEW METHODS AND TRENDS IN RAISING THE TECHNOLOGICAL, NUTRITIONAL AND FODDER VALUES OF GRAIN (ALL-UNION MEETING).

Kishinev IZVESTIYA AKADEMII NAUK MOLDAVSKOY SSR in Russian No 3, 1979
pp 90-91

[Article by V. V. Sayanova and L. A. Chilikina]

[Text] A meeting of the Coordinated Council on Problems of Raising the Quality of Grain and on Methods to Evaluate It was convened at the Moldavian Scientific Research Institute of Field Crops in Bel'tsy City. Leading specialists on quality of grain production, representing the basic selection centers, the system of the USSR Ministry of Procurement, the All-Union Association of Grain Export, and others, participated in that meeting.

The General Director, Candidate of Agricultural Sciences M. I. Snegur reported on the structure of the Scientific Production Union "Selektsiya" and perspectives for development of scientific research in the field of grain selection and quality.

Vice President of VASKHNIL (All-Union Academy of Agricultural Sciences imeni Lenin), Academician UkrSSR Academy of Sciences A. A. Sozinov and Candidate of Biological Sciences F. A. Popereya (All-Union Selection-Genetic Institute, Odessa--VSGI) devoted fundamental attention in their reports to study of the features of genetic control of grain quality traits in wheat and other plants, to devising principles of selection of pairs for hybridization, to effective methods of choice in the process of plant selection and, also, of unification of forms of recording and read-out of spectra of gliadin.

The speakers indicated that the structure of proteins is correlated to genes and that an association exists between groups of proteins and corresponding chromosomes. On the basis of data on electrophoresis of gliadins, one is able, beforehand, to predict the technological properties, frost resistance and so on, in the new, selected materials.

Hence, choice of pairs for crossing is based on electrophoretic assays. A. A. Soginov also emphasized that, in the coming decade the task of production of fodder wheat as a cheaper source of plant protein is being promoted—in connection with which determination is necessary of such very important aminoacids as lysine and tryptophan. For this reason, great attention was devoted at the meeting to a comparative study of methods for determining these aminoacids. Methods for assay of lysine and tryptophan were proposed by Candidates of Sciences A. F. Sysoyev (VSGI, Odessa) and V. G. Ryadchikov (Krasnodar Scientific Research Institute of Agriculture imeni P. P. Luk'yanenko). The unprofitability of purchase of the lysine-analyzer of the "Technicon" company, which requires enzyme lysinedecarboxylase to work, was shown; attention of the attending staff personnel of the NPO "Agropribor" [agricultural tool company] was directed to creation of a native Soviet lysine analyzer or lysinomer.

Reports were made on patterns of accumulation of proteins and carbohydrates in grain and on devising methods for control of these processes as procedures for selection and agrotechnology (Doctor of Biological Sciences A. A. Pavlov, All-Union Institute of Fertilizers and Agrotechnology, Moscow), and, also, on devising a zonal technology of growing a high-quality grain of wheat, barley and other plants (Candidate of Agricultural Sciences S. S. Sinitsyn, Siberian Scientific Research Institute of Agriculture, Omsk).

Speakers noted the possibility for early diagnosis of protein yield of grain, based on content of protein in the leaves at early stages of ontogenesis and the necessity for taking into account not only the genes of protein yield, but, also, plant metabolic activity, the capacity to assimilate soil nitrogen.

Lively discussion was evoked by the report of Candidate of Biological Sciences L. P. Kuchumova (Ukrainian Scientific Research Institute of Selection and Genetics imeni Yur'yev, Kharkov) on comparative evaluation and unification of existing methods for determination of fractional protein composition.

Candidates of Technical Sciences B. Ye. Kravtsov (All-Union Scientific Research Institute of Grain, Moscow) reported on improvement of methods to determine the quality of commercial grain and on search for new methods; Candidate of Technical Sciences V. I. Komarov (VIR--All-Union Scientific Research Institute of Plant Growing Leningrad) spoke on the characteristics of existing methods for assessment of grain quality.

Great attention was devoted to the necessity for broad cultivation of hard grains with high macaroni qualities and to improvement of evaluation of the quality of these wheats (Candidates of Agricultural Sciences V. M. Bebyakin, Scientific Research Institute of the Agriculture of the Southeast, Saratov).

V. G. Ryadchikov (Krasnodar Scientific Research Institute of Agriculture)

reported on the importance of soy as a fodder plant, which is finding wide use as a protein additive in animal rations. He noted that the soy seeds contain a number of substances which detract from their fodder quality. These include trypsin inhibitors. Technological procedures are being devised to develop seeds for lowering the content of trypsin inhibitors--a hydrothermic processing which involves pressure extrusion under heating conditions, and others. With the introduction, into animal rations, of soy which has been subjected to hydrothermic processing, a substantial rise in weight gains of the animals is seen. However, as the speaker pointed out, the cardinal way to improve fodder value of soy seeds is selection for minimal content of trypsin inhibitors. V. G. Ryadchikov further noted that it is necessary to devote more attention to high-lysine forms of normal, hard-grain corn, since mutant forms of corn with Opaque-2 gene--due to the mealiness of the endosperm--are easily injured, they get moldy and have a non-commercial appearance.

At present, investigations include improvement of the quality of the corn kernel plus concrete ways to expand the selection process for improvement of quality of the green mass of silo corn and, especially, for creation of low-lysine hybrids. For our country (the USSR), this is of special importance since 80% of all harvests of corn go to silos. According to data of V. G. Ryadchikov, feeding low-lignin corn green mass to animals raised the weight gain by 16%.

A debate was conducted at the meeting on the question of classification of district-adapted and perspective sorts of winter and spring wheat, based on quality groups.

The resolution adopted emphasized--along with questions of training of scientific cadres, development and improvement of methods to evaluate the quality of grain cultures, broad use of the achievements of genetics in selection research, etc.--the necessity of installing modern technological equipment in laboratories engaged in study of the quality of wheat grain.

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MOLECULAR-GENETIC MODEL OF THE PROCESS OF AGING: THE ACCUMULATION OF GENETIC LESIONS AND THEIR REPAIR

Moscow ZHURNAL OBSHCHEY BIOLOGII in Russian No 3, 1979 pp 458-466

[Article by V. K. Rabin, V. V. Yurashev, Institute of Chemical Physics, USSR Academy of Sciences, and the Moscow Institute of Electronic Engineering. The article was received at the editorial office 26 June 1977]

[Text] A molecular-genetic theory of aging is offered. During life the constant formation of repairable and nonrepairable lesions of genes occurs. For a diploid cell a lethal event is considered to be a lesion of both copies, even of only one gene. A part of the repairable lesions are removed by the system of repair, whose activity decreases in measure of the accumulation of repairable and nonrepairable lesions. As a consequence of this the speed of the accumulation of lesions increases during the life of the cell.

A mathematical analysis of the model was carried out, the results of which were compared with real curves of survival with the assumption about the equality of the probabilities of the death of the cell and the organism. The question about the immortality of sex cells and about the possibilities of prolonging life are considered.

The idea about the accumulation of genetic injury as the basic cause of aging and death in the last several years received a wide dissemination, although it remains entirely conjectural (Streler, 1964; Cutler, 1972). In the present work an attempt at the quantitative analysis of this phenomenon was made on the basis of contemporary data about the repair of genetic injuries on the level of molecules of DNA.

As a basis was taken the conception developed in the works of N. M. Emanuel' about the role of critical phenomena in biological processes,

well documented on examples of tumorous growth and the aging of polymers and formally applied also to processes of aging of man (Emanuel', 1975; Emanuel' and coauthors, 1964).

In distinction to the early work of Szillard devoted to this question (Szillard, 1959), in our work are examined not the injuries of whole chromosomes, but injuries of separate genes, which is entirely essential, taking into account the possibility of their repair. This allows us to calculate the kinetics of mortality only on the basis of a molecular-genetic constant, not drawing in data of a population character.

The Model of the Accumulation of Genetic Injuries in the Cell

Under the term "genetic injury" we will mean any change of the gene making it biologically useless, that is, not able to code the structure of active protein. Only those genetic injuries are examined which affect one gene. We will distinguish repairable and nonrepairable injuries. Examples of repairable injuries are dimers of pyrimidines, short single stranded breaches, etc., examples of nonrepairable injuries are deletions or insertions. One may find a detailed examination of the types of injuries of DNA in a series of reviews and monographs (Soyfer, 1968; Okada, 1974). One and the same influence on the cell can as a rule lead to injuries to DNA of both types arising. At the same time the quantity of repairable injuries is usually many times larger than the quantity of nonrepairable injuries.

Speaking about repair, we will have in mind any process of removal of injuries from a molecule of DNA possessing the following properties. If $n(t)$ is the number of injuries at the moment of time t , and ψ is the constant of the speed of repair, then,

$$n(t) = n(0)e^{-\psi t}$$

The kinetics of the repair by way of cutting out and resynthesis in bacteria obeys this rule (Setlow, 1964; Setlow et al., 1968; Boyle, Setlow, 1970). Although for eukaryotic cells at the present time there isn't sufficiently detailed research of repair kinetics, there is no basis to think that this law will not be fulfilled for them, in any case as a first approximation. (In essence, this law is acceptable for all reactions in which the reaction velocity is proportional to the product of the concentration of unreacted substrate and the concentration of enzyme.)

Ten specific enzymes participate in repair. Moreover, the ability to repair an injury may worsen upon damage of energetic and a series of other processes not linked directly with the repair of DNA. With a large number of injuries the possibility arises of an injury of one or several genes directly or indirectly influencing the process of repair. This should lead to a decrease in the speed of restoration. Although

such a decrease has actually been noted in a series of works, quantitatively this question is insufficiently studied. However there is numerous data about the decrease of activity of other enzyme systems after irradiation (see summary, Okada, 1974). In these investigations it is established that enzymatic activity decreases exponentially upon increasing the dose of irradiation. It is fully natural to think that for the repair of DNA in the dark, also an enzymatic process, that same regularity must be observed, that is:

$$\psi(N) = \psi(0)e^{-\alpha N}, \quad (1)$$

where N is the general number of injuries, that is, the sum of the number of repairable (n) and nonrepairable (m); α is a constant.

One should remember that usually the bacterial cell contains 2-4 identical chromosomes and therefore the experimentally established fact of the exponential decrease of enzymatic activity in bacteria, obviously, is not a specific property of haploid organisms. That gives us the basis of using formula (1) for eukaryotic cells too.

If injuries elicited by radiation affected not more than one gene each and if all genes were independent then obviously the magnitude α would be equal to the share of genes whose function is necessary for repair and formula (1) would be a simple consequence of the target theory, including for eukaryotes. However the experimentally discovered values α for a series of enzymes comprise from 0.18 to 1.00 which exceeds by many times the probable dimension of the corresponding genes. This occurs at least partly because a significant part of injuries from roentgen radiation affects many genes. In our model only spontaneous injuries are examined which affect one gene and therefore the constant α has a simple biological sense as the share of genes whose function is essential for the repair of DNA. As is shown below, $\alpha \approx 0.5\%$, which seems like a reasonable value for eukaryotic cells.

It is necessary to note that formula (1) is good for the description of sufficiently slow processes. Actually, the inactivation of genes only leads to a decrease of the speed of repair when the synthesis of new enzymes is necessary for the repair process and at the same time it becomes not indifferent whether the corresponding genes are damaged or not. It is well known, that in order to complete repair in the dark the synthesis of protein is necessary, although individual stages of the process (incision, ligation reaction) may proceed in its absence. We will, on the other hand, presuppose that the process of repair is sufficiently swift in comparison with the length of life of the whole organism, which doubtlessly is justified. We will also not take into account the possibility of a change of the properties of the cell in the process of multiplication and selection within the confines of the organism.

Thus, one may describe the accumulation of genetic injuries in the cell in the following way. As a consequence of chemical reactions elapsing in the cell as well as on account of external causes there arises a constant background of injuries in DNA consisting of repairable (β injuries in a unit of time) and nonrepairable (λ injuries in a unit of time) components. The system of dark repair eliminates the greater part of repairable injuries, but its activity will gradually decrease, as the accumulation of injuries will continue to take place (the non-repairable component and a part of the repairable injuries not yet having time to be repaired). In measure of the decrease of the activity of repair the tempo of the accumulation of injuries will grow since a still greater share of repairable injuries will not be repaired. Finally, the tempo of the accumulation of injuries will simply correspond with the speed of their introduction. It is necessary to note that if the very fact of the existence of repair of DNA in the cells of animals does not elicit doubts, the significance of repair, as in general the significance of injuries of the molecules of DNA in the process of aging, is not proven. The available experimental facts about the change of repair in the course of aging are extremely contradictory (Vilanchik, 1970; Hart, Setlow, 1974). These contradictions may be solved only with an experiment; the theory expounded here shows that if one takes the point of view of the adherents of the role of DNA and repair in the process of aging then reasonable quantitative and qualitative results are obtained which, of course, still does not prove the correctness of the initial positions.

The Kinetics of the Accumulation of Genetic Injuries

The quantity of nonrepairable injuries, obviously, grows linearly according to the law

$$\frac{dm}{dt} = \lambda.$$

Over a short interval of time Δt the increase of the number of repairable injuries comprises $\Delta n = \beta \Delta t$ which is the number of repairable injuries over the time Δt .

Inasmuch as repair proceeds according to the law

$$n(t + \Delta t) = n(t)e^{-\phi \Delta t} \approx n(t) (1 - \phi \Delta t),$$

then over the interval of time Δt , $n\phi\Delta t$ injuries will be repaired.

Consequently, $\Delta n = \beta \Delta t - n\phi \Delta t$.

Taking into account the dependency $\phi(N) = \phi(0)e^{-\alpha N}$, where $N = n + m$, finally we obtain:

$$\Delta n = [\beta - n\psi(0)e^{-an}e^{-at}]\Delta t$$

and after obvious operations

$$\frac{dn}{dt} = \beta - n\psi(0)e^{-an}e^{-at}.$$

Thus, for the full number of injuries $N = m + n$ we have a system of equations.

$$\frac{dm}{dt} = \lambda; \quad \frac{dn}{dt} = \beta - \psi(0)ne^{-an}e^{-at}$$

or, thinking that $\psi_0 = \psi(0)e^{-am_0}$, we obtain: $N = n + m_0 + \lambda t$, where n is defined from the equation

$$\frac{dn}{dt} = \beta - \psi_0 ne^{-an}e^{-at} \quad (2)$$

with the initial condition $n(t = 0) = n_0$. Here ψ_0 is the repair ability at the moment of birth, n_0 and m_0 are the initial values of the number of repairable and nonrepairable injuries. Concerning these magnitudes one may note the following: m_0 is a measure of the mutation load accumulated by previous generations and generally speaking $m_0 \neq 0$. If the question concerns the successive generations of the organisms forming a population, then one may reckon, that natural selection rejects the value m_0 strongly exceeding the average value and in a series of consecutive generations m_0 must either remain relatively constant or slowly change in accord with the evolution of the genome of the given species. The quantity of repairable injuries at the moment of birth must be minimal and close to magnitude β/ψ_0 . Actually, with a small n and t equation (2) can be rewritten to be

$$\frac{dn}{dt} \approx \beta - \psi_0 n.$$

Its solution:

$$n = \frac{\beta}{\psi_0} - \left(\frac{\beta}{\psi_0} - n_0\right)e^{-\psi_0 t}.$$

This solution is schematically shown in Figure 1 for two values n_0 , one of which is bigger, and the other smaller than β/ψ_0 . It is natural to suppose that $1/\psi_0$ is much less than the lifetime of the organism. Therefore it is clear that independently from the initial value n_0 , the magnitude n in the first "childhood" years will approach β/ψ_0 including for $n_0 = 0$. This gives a basis to suppose in the future that $n_0 = 0$, which is fully reasonable from the biological point of view.

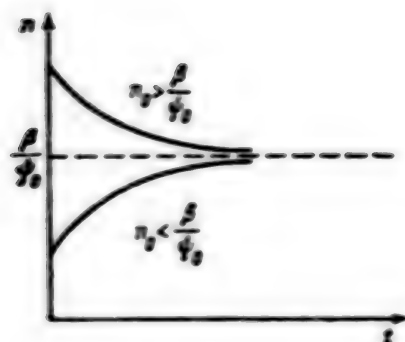


Figure 1. The behavior of the solution of equation (2) with small n and t .

Introducing the symbols $a = \alpha\beta/\psi_0$; $z = \alpha n$; $x = \psi_0 t$; $R = \lambda/\beta$, equation (2) can be taken down in the form

$$\frac{dz}{dx} = a - ze^{-z}e^{-akx}. \quad (3)$$

Unfortunately, equation (3) does not yield to an analytical solution. As the quantitative evaluations of the biological data and survival curves show, values of $k \ll 1$, $a \sim e^{-1}$, and z from 0 to 5 are of interest. For a series of values a and k equation (3) was solved numerically (by the method of Runge-Kutta with $n_0 = 0$ on the electronic computer "World-7") and the drawing of several solutions, as well as a table of values x , corresponding to $z = 5$ are given in Figure 2 and in Table 1. As is obvious from these results and also directly from equation (3), upon decreasing a and k the length of life can be made as great as one wants, but it can become endless only if $a < e^{-1}$ and $k = 0$. Biologically this corresponds to a sufficiently active system of repair, and what is especially important, to the absence of nonrepairable injuries.

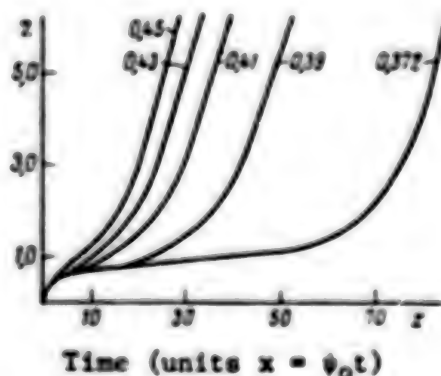


Figure 2. Integral curves of equation (3) with $k = 10^{-3}$. The numbers by the curves show the corresponding value of a .

Table 1. Values of x at Which $z = 5$, According to the Results of the Numerical Solution of Equation (3)*

x	z				
	10^{-4}	10^{-3}	$2.5 \cdot 10^{-3}$	$5 \cdot 10^{-3}$	$7.5 \cdot 10^{-3}$
0.090				429.3	313.4
0.268		182.1	96.2	63.9	51.8
0.368	99.9	49.0	37.6	30.7	27.4
0.372	81.9				
0.400	41.1	34.3	29.4	25.5	23.3
0.450	25.4				
0.600	13.4			12.3	

Note. The value of $z = 5$ with $\alpha = 0.01$ and $M = 30,000$ corresponds to a survival ≈ 37 percent.

The Calculation of the Probability of the Death of the Cell

The theory expounded allows one in principle to calculate the quantity of genetic injuries in the genome of the cell irrespective of whether this cell is dividing or not. If the matter is a question of diploid cells then it is logical to accept, that the death of the cell will ensue in that case, if both copies even of only one of the genes will be affected. With the general number of pairs of genes M and N and the genetic injuries accidentally distributed to them, the probability of the survival can easily be calculated and is

$$p = [1 - (1 - e^{-\frac{N}{2M}})^2]^M. \quad (4)$$

The Kinetics of Mortality

It is beyond doubt that between the probabilities p_i of the death of individual cells and the probability P of the death of the organism a definite dependency $P = F(p_i)$ exists, for whose exact establishment it is necessary to know the relative physiological significance and numbers of all types of cells, to take into account their interaction and much else that distinguishes the whole organism from a simple aggregate of cells. Unfortunately, this is such a complicated question both in an experimental and in a theoretical relationship that we are forced to choose what is known to be a simplified form of the mentioned dependency. To begin with we will suppose that all $p_i(t)$ are identical. This means, first, that the stream of genetic injuries on the average is identical for all the cells, and secondly, that the probability of the death of a cell depends only on the quantity of injuries in the molecules of DNA, but not on the type of cell. At the present time we know nothing about the molecular nature of chromosomal injuries causing aging and therefore one cannot say anything about whether the speed of their arising for

cells of various types is identical or not, which touches on a second assumption founded on a fact well known from radiobiology, that the radiosensitivity of cells correlates with their content of DNA and depends little on the type of cell (the more so for cells of one and the same organism). Another argument in favor of the assumptions about the identical $p_1(t)$ is the well known fact that the animal or human organism dies not from any always similar pathology, but from the most varied pathologies. This can be examined as evidence of "equality" of various types of cells in the process of aging and death. Thus instead of dependency $P = F(p_1)$ we will examine dependency $P = F(p)$, limiting ourselves to the examination of only the two simplest forms of the function $F(p)$: the graduated and the linear. The first form means that the organism perishes only when a defined share of cells perish of which it consists. This assumption was used in his time by Szillard. If this was correct, then it followed to expect that the dosage dependency of survival upon irradiation also would have the appearance of a graduated function, which is not observed, as is well known, in reality. Another argument in favor of the linear dependency of P on p is the near correspondence (within the limits of one order) of D_{37} for the whole organism and for individual cell lines. Thus for several lines of human cells D_{37} is from 105-300 rad., for the mouse D_{37} is from 65-594 rad., for the Chinese hamster D_{37} is from 315-427 rad., for the monkey D_{37} is from 186-252 rad. The corresponding values for animals are around 400, 500-700, 1200, around 600 (cited by Okaga, 1974). Thus, there is a basis to examine the assumption about the equal probability of the death of the organism and the cells or the first rough approximation to reality. (Against this assumption people often cite well known facts about the organism's loss of a large number of cells upon amputation and other localized processes which is linked, obviously, with a lack of understanding of the significance of the word probability. If, for example, the probability of the death of cells is 10 percent, then this means, roughly speaking, that all organs lose 10 percent of their cells which obviously is not at all equivalent to, say, the amputation of a tail.)

It is necessary to underline that the assumption about the equality of the probabilities of the death of the cell and the organism still remains a postulate of the theory, that is, the theory strictly relates only to such organisms as satisfy it, all the above reasoning given only so that there was the possibility to evaluate to what extent this may correspond to reality. In the process of aging the dying off of cells and the birth of new ones occurs, and in principle in such a population which is being renewed the selection of good cells may proceed, that is, of cells, in the DNA of which on the strength of one or another cause there are fewer injuries, than in the basic mass of cells on the average. In our model selection is not taken into account not only because we do not have any quantitative descriptions of this process for all types of cells of the living organism but also because the systematic selection of more viable cells should not be a usual phenomenon in the process of aging, insofar

as such selection will lead to the development of malignant growth, which already exceeds the bounds of the normal process of aging analyzed by us. Thus, we will suppose that the process of birth and death of cells at the time of aging essentially does not change the gene fund of the cell population and the genetic injuries present at the given moment of time are transferred in an unchanged form to the descendants of the given cell; the possible influence of selection between daughter cells we will neglect for the reasons mentioned above. Thus, knowing the magnitudes α , β , ψ_0 , λ , m_0 and M , with the help of equations (2) and (4) it is possible to calculate the kinetics of mortality. Although all these parameters are accessible to experimental definition, their values are still unknown if one does not compute the rather rough estimate of the number of genes M --from 30,000 to 100,000 and the tempo of mutation from 10^{-6} to 10^{-7} per gene for one division of the somatic cell (Shapiro, Varshaver, 1976).

This gives an estimate for λ from $3 \cdot 10^{-3}$ to $3 \cdot 10^{-1}$ hits on the genome over the time equal to the average time of division of the somatic cell in the organism. Insofar as the number of such divisions does not exceed 100 (Kheyflik, 1972), then it is obvious, that the contribution of nonrepairable injuries (that is λt) comprises not more than 10 over the entire lifetime. Meanwhile in agreement with formula (4), $p = 50\%$ with $N = 410$. Consequently, the accumulation of nonrepairable injuries or mutations probably is not an essential factor determining the length of life.

Thus, in agreement with the theory expounded, death of the organism arrives as a result of the accumulation of repairable injuries, that is, eliciting temporary inactivation of the gene or the decrease of the activity of the corresponding protein. Magnitudes α , β , ψ_0 may be determined by means of a comparison of the theoretical curves $P(t)$ calculated according to equations (2) and (4) with real survival curves. The results of such calculations for several species of animals and for man are summarized in Table 2. In these calculations M was taken = 30,000 and $m_0 = n_0 = \lambda$ was taken = 0.

In Figures 3 and 4 are shown real and theoretical survival curves for man and rats. As we see, the theoretical curves with the corresponding values of parameters α , β , ψ_0 approximate well the experimental data.

From Table 2 it is seen that magnitudes β and ψ_0 change within very wide limits. At the same time the value for α fluctuates from $3 \cdot 10^{-2}$ to $14 \cdot 10^{-3}$ (in the majority of cases $\alpha \approx 5 = 7 \cdot 10^{-3}$), and the ratio β/ψ_0 is from 40 to 180. This has an obvious biological sense, since it is roughly speaking the share of repairable genes, and it must not vary strongly, and the constancy of the ratio β/ψ_0 reflects the natural correlation between the speed of entry of injuries and the ability to repair them.

Table 2. Values of Magnitudes α , β , and ψ_0 , Calculated According to Survival Curves

(1) Организм	(2) Единица времени	T_{50}	$\alpha \cdot 10^3$	ψ_0	β	$\beta \cdot \psi_0$	$\alpha = \frac{\alpha \beta}{\psi_0}$	(3) Литературные данные
(4) Легочные моллюски <i>Limnaca columella</i>	(13) дни	180	4.80	0.09	7.49	83.0	0.400	(16) Комфорт (1967)
(5) Коловратки <i>Philodinae citrina</i>	"	27	5.30	0.79	66.0	83.5	0.440	То же (17)
(6) <i>Drosophila subobscura</i> Линии В и К	"	32	3.20	0.10	18.3	183	0.585	"
(7) <i>Drosophila</i> гибрид линий В и К	"	67	4.70	0.17	16.4	97	0.452	"
(8) Чистокровные кобыты 1860—1864 гг.	(14) годы	22	4.70	0.525	50.8	97	0.455	"
(9) Мыши C_3H самки	(15) месяцы	23.5	4.20	0.60	64.4	108	0.450	"
(10) Мыши IAF ₁	"	23.0	8.40	0.68	69.5	103	0.82	"
(11) Крысы	дни	820	9.80	0.016	0.908	57	0.560	"
(12) Крысы	дни	770	12.0	0.033	1.24	37.5	0.450	Brunaud, 1971
(12) Человек	годы	70	10.0	0.55	22.0	40	0.400	Wolfbein, 1957

Key:

- | | |
|------------------------------|---------------------------|
| 1. Organism | 10. IAF ₁ mice |
| 2. Unit of time | 11. Rats |
| 3. Data from the literature | 12. Man |
| 4. Lunged mollusks | 13. Days |
| 5. Rotifers | 14. Years |
| 6. Lines B and K | 15. Months |
| 7. A hybrid of Lines B and K | 16. Komfort (1967) |
| 8. Pure blooded mares | 17. Ibid. |
| 9. Female C_3H mice | |

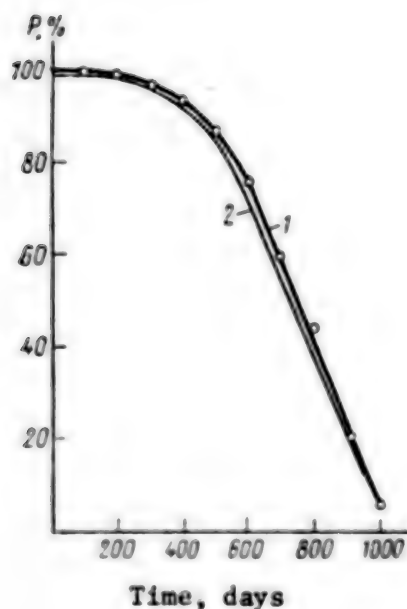


Figure 3. Survival curves of rats: 1--factual data, 2--the theoretical approximation with $\alpha = 0.012$, $\beta = 1.24$, $\psi_0 = 0.033$; $m_0 = n_0 = \lambda = 0$; $M = 30,000$.

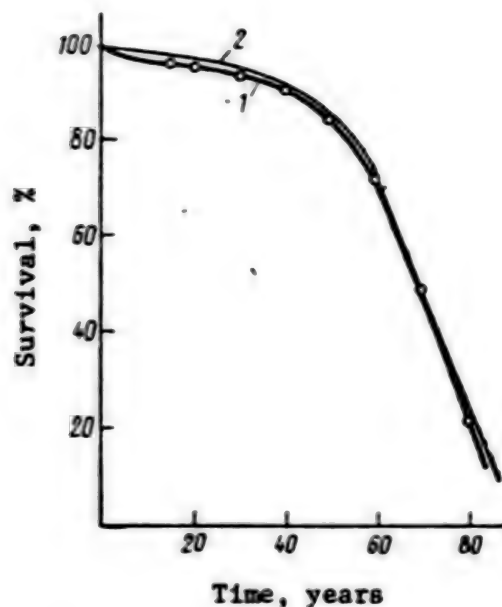


Figure 4. Survival curves for man: 1—factual data (USA, 1955); 2—theoretical approximation with $\alpha = 0.01$, $\beta = 22.0$ and $\psi_0 = 0.55$; $m_0 = n_0 = \lambda = 0$, $M = 30,000$.

Inasmuch as for all the analyzed species of animals the magnitude $a = \alpha\beta/\psi_0 > e^{-1}$ then with $\lambda t = m < 10-30$ the factor $e^{-\alpha\lambda t}$ in equation (2) or e^{-akx} in equation (3) does not essentially influence the course of the integral curves. This means that the really existing tempo of mutation ($\lambda t < 10$) is not a deciding factor determining the length of life.

Thus, upon analyzing real survival curves the theory gives reasonable conclusions from a biological point of view.

Sexual Cells

Beginning with the works of Weismann, the conception about the immortality of sexual cells received wide dissemination. There is hardly any sense to talk about the absolute immortality of sexual cells, that is, about the immortality during endless time, since already during thousands of generations in the real population as a result of the action of selection, of drift of genes, etc. the change of the genotype of individuals takes place, that is, the change of these very sexual cells. Therefore it is more realistic to examine the immortality of sexual cells on only a limited interval of time of the order of hundreds or thousands of generations.

If one assumes that in sexual cells the stream of genetic injuries is less, and repair is more active, then according to the theory expounded, a sharp increase in the length of life will be observed. Thus, with a

decrease of the size of a from 0.400 to 0.200 the length of life increases not 2, but more than 10 times. In general, with a $< e^{-1}$ and with small values of λ ($\sim 10^{-2}$) the length of life is already defined basically only by the tempo of mutation and with a frequency of mutation $\sim 10^{-5}$ per gene over a gamete generation, it is hundreds of generations. The assumption about the lower stream of genetic injuries in sexual cells agrees with the well known fact of the lower mutability of sexual cells in comparison with somatic cells (Shapiro, Varshaver, 1976).

Thus, to explain the "immortality" of sexual cells it is not necessary to assume the existence of any principally qualitative differences in the mechanisms of aging of sexual and somatic cells; it is sufficient, in accordance with the theory expounded to assume that in the sexual cells the same causes of aging act, but with rather decreased intensiveness.

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CHANGES IN HEART RATE AND RESPIRATION ACCOMPANYING BEHAVIORAL REACTIONS
ELICITED BY ELECTROSTIMULATION OF THE CAUDATE NUCLEUS AND THE HYPOTHALAMUS

Kiev FIZIOLOGICHESKIY ZHURNAL in Russian No 1, 1979 pp 9-15

[Article by B. A. Stremousov and N. I. Red'ko, Department of Normal
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[Text] One of the least studied aspects of the activity of the forebrain's caudate nuclei is their participation in regulation of autonomic functions and, in particular, cardiac activity and respiration. Polymorphic changes in these functions have been described in the literature in response to stimulation of caudate nuclei; these changes have arisen on their own or in conjunction with certain behavioral responses (1,2,7,11,12,18). In chronic experiments, some authors observed growth in heart rate (1,12) while others observed rate changes of different directions, closely associated with the specific features of the behavioral responses (8,11). Various changes have also been noted in respiration--faster breathing (3,18), faster breathing coupled with reduced amplitude (8), and faster breathing alternating with slower breathing (1). The relationship between cardiac and respiratory components in behavioral reactions produced by stimulation of caudate nuclei has not been studied. In our opinion, research on this problem in comparison with the responses produced by stimulating the hypothalamus, the most widely studied brain structure, would permit us to make sounder conclusions concerning the participation of the caudate nuclei in suprabulbar mechanisms regulating cardiac activity and respiration.

Research Methods

The experiments were conducted on adult mongrel cats into which bipolar macroelectrodes were implanted into the caudate nuclei (CN) and the posterior division of the hypothalamus (PH), using coordinates suggested in the atlas compiled by Jasper and Ajmon-Marsan (16). The experiments were performed 5-6 days after the operation. Stimulation was produced by a 30 Hz 0.01-0.15 ma sinusoidal current at a voltage of up to 3 volts. Stimuli 10-20 sec long were applied at intervals of 3-5 min. The second standard points of contact were used to record the EKG. Respiration was recorded with a strain gage and an 8EEG-1 recorder on the basis of change in rib cage circumference.

Breathing amplitude was determined from change in the sweep of the recording stylus and expressed as a percentage of the initial amplitude. Behavior was recorded on a data sheet. The experiments were repeated after 2 or more days. We performed 103 experiments on 18 cats. Respiration and behavior were studied with six cats, and heart rate, breathing, and behavior were studied with 12. We recorded 577 results from stimulating 24 CN points and four PH points. After the experiments the brains of the animals were fixed in formalin, following which we determined the locations of the points of stimulation more definitely. The data were subjected to statistical treatment using the direct differences method (9) and Spearman's rank correlation method (14).

Research Results

Stimulation of CN's and PH's elicited changes in the frequency of cardiac contractions and respiration, differing in both qualitative and quantitative respects. Reactions in heart rate to stimulation of the CN had a longer latent time (4.1 as opposed to 2.2 sec) and a shorter aftereffect time (10.8 as opposed to 17.5 sec) in comparison with the values obtained with stimulation of the hypothalamus ($p < 0.001$). Within the CN, the latent time was shorter (3.3 as opposed to 4.9 sec) and the aftereffect time was greater (12.0 as opposed to 9.6 sec) for the caudal divisions than the rostral divisions ($p < 0.001$).

The dominant reaction of heart rate to stimulation of the CN was its increase by 3-21 beats/min (with stimulation of 53 percent of the points), both during the time of stimulation and after it (Table 1). Stimulation of 33 percent of the points, located predominantly in the caudal divisions of the CN, was accompanied by a drop in heart rate by 2-40 beats/min followed by an increase of 2-8 beats/min. Changes were found to be more profound with stimulation of the PH. The cardiac contraction rate of all cats grew by 30-39 beats/min, and only in cat No 1 was the increase preceded by a decrease of 21 beats/min.

Respiratory reactions to stimulation of the CN varied in their direction and had a lower latent time than did changes in heart rate (3.3 as opposed to 4.1 sec); when the PH was stimulated, the changes in respiration and heart rate occurred simultaneously. Breathing reactions were always longer than changes in the frequency of cardiac contractions, the reaction aftereffect time being greater for the PH than the CN (22.7 as opposed to 14.6 sec).

The caudate nuclei of six cats used only for investigation of respiratory and behavioral reactions were stimulated with threshold currents or with supra-threshold currents close to threshold. Such stimulation reduced the deepness of breathing ($-19 \pm 4\%$; $p < 0.001$) without significant changes occurring in breathing frequency. Twelve cats were subjected to suprathreshold current intensities (1.5-2 times above threshold), which allowed us to observe complete development of the behavioral reaction, as well as its cardiac and respiratory components. In this case the structure of respiratory reactions differed from

Table 1. Changes in Cardiac Contraction and Respiration Frequency in Response to Stimulation of the Caudate Nucleus and the Hypothalamus

(1) № кошки	(2) Частота сердечных сокращений			(5) Частота дыхания		
	(3) Исходная частота $M \pm \sigma$	(4) Изменение при раздражении $D \pm m(D)$	p	(3) Исходная частота $M \pm \sigma$	(4) Изменение при раздражении $D \pm m(D)$	p
(6) Ростральные отделы ХЯ						
1	211 \pm 5	-40 \pm 4	<0,001	39 \pm 6	+8 \pm 6	>0,2
2	169 \pm 3	+6 \pm 2	<0,02	43 \pm 5	+13 \pm 3	<0,001
3	136 \pm 2	+11 \pm 2	<0,001	21 \pm 2	+18 \pm 7,5	<0,05
4	169 \pm 6	+12 \pm 5	<0,05	45 \pm 3	+6 \pm 5	>0,2
5	133 \pm 2	+8 \pm 3	<0,05	34 \pm 3	+14 \pm 6	<0,05
7	162 \pm 1	+6 \pm 2	<0,01	50 \pm 3	+5 \pm 2,3	<0,05
9	96 \pm 4	+8 \pm 2	<0,01	30 \pm 1	+18 \pm 4	<0,01
12	86 \pm 2	+4 \pm 2	>0,05	35 \pm 3	+28 \pm 8	<0,01
(7) Кaudальные отделы ХЯ						
1	200 \pm 3	-33 \pm 4	<0,001	36 \pm 2	+30 \pm 4	<0,001
2	154 \pm 2	-4 \pm 1,5	<0,05	58 \pm 4	+25 \pm 5	<0,001
3	129 \pm 6	+8 \pm 5	>0,1	22 \pm 2	+18 \pm 7	>0,05
6	114 \pm 2	-8 \pm 2	<0,001	22 \pm 2	+1 \pm 1	>0,5
11	107 \pm 2	+2 \pm 0,9	<0,05	34 \pm 6	+16 \pm 5	<0,01
13	171 \pm 5	+17 \pm 4	<0,001	66 \pm 6	+43 \pm 9	<0,02
14				27 \pm 1	+41 \pm 9	<0,02
(8) Задний отдел гипоталамуса						
1	191 \pm 7	+36 \pm 5	<0,001	29 \pm 3	+37 \pm 8	<0,05
6	104 \pm 2	+39 \pm 5	<0,001	25 \pm 2	+22 \pm 4	<0,001
7	174 \pm 7	+32 \pm 8	<0,001	47 \pm 1	+17 \pm 4	<0,01
14	135 \pm 4	+30 \pm 10	<0,05	25 \pm 2	+16 \pm 3	<0,01

Note: Frequency is given in cycles per minute. M --Arithmetic mean; σ --standard deviation; D --arithmetic mean of difference; $m(D)$ --mean error; p --significance of difference.

Key:

- | | |
|--|---|
| 1. Cat, No | 5. Respiration frequency |
| 2. Cardiac contraction frequency | 6. CN, rostral divisions |
| 3. Initial frequency, $M \pm \sigma$ | 7. CN, caudal divisions |
| 4. Change in response to stimulation, $D \pm m(D)$ | 8. Posterior division of the hypothalamus |

that observed with the first six cats. Changes in the frequency of respiratory movements assumed dominance: Faster breathing was observed in 77 percent of the cases. The caudal divisions of the CN reacted more constantly and more in the same direction than did the rostral divisions. Stimulation of the former resulted in more frequent breathing. At the same time the depth of breathing changed significantly only in cats No 1 and 7: It decreased by 37-43 percent in the former ($p < 0.001$) and increased by 11 percent in the latter ($p < 0.01$).

Respiratory reactions produced by stimulation of the PH were distinguished by better reproducibility and greater constancy of direction than those produced by stimulation of the CN. In all cases of stimulation of the PH, the breathing rate increased by 15-17 cycles/min (Table 1), and in 77 percent its depth dropped by 17-30 percent ($p < 0.05$).

Because respiratory reactions preceded changes in heart rate upon stimulation of the CN, in order to reveal the relationship between changes in breathing and heart rate we first subdivided all results into two groups depending on whether the frequency of respiratory movements increased or decreased, and then for each group we determined the percent ratio of changes in cardiac rhythm proceeding in different directions. Next we subdivided the data and computed the ratio of heart rate changes in the same way in relation to cases of increasing and decreasing breathing depth (Table 2).

This permitted us to reveal the following features. When the rostral divisions of the CN were stimulated, change in breathing was accompanied more frequently by tachycardia, while when caudal divisions were stimulated the change was usually accompanied by bradycardia. In both cases the increase in breathing rate was accompanied more frequently by tachycardia, while a decrease was accompanied usually by bradycardia. Stimulation of rostral divisions resulted more often in tachycardia when breathing depth increased, and bradycardia when breathing depth decreased; when the caudal divisions were stimulated, meanwhile, bradycardia developed more frequently in the presence of both an increase and a decrease in breathing depth. After the stimulatory current was shut off from the CN these laws in the relationships between heart rate and respiration disappeared, and tachycardia was observed more often in the presence of all breathing alterations.

When the PH was stimulated, in all cases tachycardia arose simultaneously with faster breathing as well as with a decrease in its depth (in 77 percent of the cases) or an increase in its depth (23 percent). Tachycardia combined with faster breathing and lower breathing depth dominated. This same combination was also observed most often after the stimulatory current was shut off; however, in a number of cases a decrease in breathing rate was accompanied by bradycardia.

Statistical treatment of the results revealed a noticeable positive correlation between changes in heart rate and the frequency of breathing movements in response to stimulation of 6 out of 16 CN points (r varied from

Table 2. Ratio of Changes in Heart Rate and Breathing in Response to Stimulation of the Caudate Nucleus and the Hypothalamus

(1) Состояние показателей дыхания		(2) Соотношение изменений сердечного ритма, в %								
		(3) Хвостатое ядро						Задний отдел гипоталамуса (9)		
		(4) ростральные отделы			(5) каудальные отделы			тахикардия (6)	брадикардия (7)	без изменений (8)
тахикардия (6)	брадикардия (7)	без изменений (8)	тахикардия (6)	брадикардия (7)	без изменений (8)					
(10) При раздражении										
(11)	Учащение дыхания	58	28	14	28	46	26	все 100 % раздражений сопровождалось учащением сердечного ритма (10)		
(12)	Урежение дыхания	50	33	17	8	92	—			
(13)	Увеличение глубины дыхания	65	15	20	23	46	31			
(14)	Уменьшение глубины дыхания	40	43	17	22	58	20			
(15) После раздражения										
(11)	Учащение дыхания	68	18	14	65	12	23	71	23	6
(12)	Урежение дыхания	55	18	27	35	35	30	40	60	—
(13)	Увеличение глубины дыхания	64	—	36	61	11	28	67	28	5
(14)	Уменьшение глубины дыхания	66	17	17	60	15	25	77	18	5

Key:

- | | |
|---|---|
| 1. Breathing characteristic responses | 11. Growth in breathing frequency |
| 2. Ratio of changes in heart rate, % | 12. Decrease in breathing frequency |
| 3. Caudate nucleus | 13. Increase in breathing depth |
| 4. Rostral divisions | 14. Decrease in breathing depth |
| 5. Caudal divisions | 15. After stimulation |
| 6. Tachycardia | 16. All cases of stimulation were accompanied by growth in heart rate |
| 7. Bradycardia | |
| 8. No change | |
| 9. Posterior division of the hypothalamus | |
| 10. During stimulation | |

+0.57 to +0.68; $p < 0.01$), and high correlation between these characteristics in two cats out of four in response to stimulation of the PH ($r = +0.77$; $p < 0.02$). Correlations were not revealed statistically between the frequency of cardiac contractions and breathing depth.

Stimulation of the CN by threshold currents produced typical behavioral reactions--general alertness and orientational-exploratory reflexes. These

reactions also occurred at the beginning of stimulation with stimuli of greater intensity. They correlated with bradycardia, with slower breathing, and sometimes with short-term apnea (4-6 sec). These reactions developed more noticeably with stimulation of caudal divisions of the CN.

Of interest is the high individuality of these reactions in particular animals exhibiting different types of nervous activity. Compare, for example, the reactions of cats No 1 and 3. Electrodes were implanted in these cats at identical coordinates, in the rostral divisions of the CN on one side and in the caudal divisions on the other. Stimulation of both points in cat No 1, distinguished by motor restlessness and imbalanced behavior, was accompanied by a clearly pronounced orientational-exploratory reaction coupled with elements of anxiety. This was also typical of its reactions to stimulation of the PH. When all three points were stimulated simultaneously the cat developed bradycardia with a short latent time (0.5 sec), the respiration frequency increased, and breathing depth declined, sometimes going as far as short-term apnea.

Cat No 3, which was calm and balanced, exhibited a poorly pronounced reaction of general alertness at the beginning of stimulation of similar points, accompanied only by changes in respiration frequency, with no changes occurring in breathing depth. Tachycardia arose following a long latent period (7 sec) concurrently with the motor reaction, and it did not attain its maximum until the stimulus was shut off. The stage of orientational behavior was also distinguished by individuality in other animals. In addition, development of identical motor reactions--turning of the head and body in the contralateral direction--was as a rule accompanied in all animals by tachycardia and faster breathing, with no significant changes occurring in breathing depth.

Stimulation of the PH produced behavioral effects of greater complexity.

First came orientational-exploratory reactions coupled with restless exploratory movements, dilation of the pupils, piloerection, and elements of aggressive behavior. These manifestations correlated with tachycardia, faster breathing, and reduced breathing depth. After the stimulus was shut off we observed licking motions and swallowing movement combined with bradycardia and slower breathing.

Discussion of Research Results

The research results presented here show that stimulation of the CN was regularly accompanied by changes in heart rate, respiration, and behavior; despite their polymorphism, these changes were to a certain extent specific in comparison with those accompanying stimulation of the hypothalamus. Comparing our results with the data of other authors, we revealed definite similarities on one hand and certain differences on the other. As in Suvorov's research (12) we observed tachycardia in response to stimulation of the CN, while with activation of its caudal division bradycardia arose. In contrast

to studies in which only faster breathing (3,18) or faster breathing coupled with reduced amplitude was observed (8), we observed both a decrease and an increase in the frequency and depth of breathing. Our data on changes in heart rate in response to stimulation of the PH are consistent with what is usually found; however, in contrast to the information of other authors (5,17) the breathing changes were distinguished by greater constancy of direction.

It has been hypothesized that the brain's suprabulbar structures lack clearly delimited centers responsible for regulation of breathing and circulation (6,10). It is believed that the mechanisms regulating these functions at the cortical-subcortical level are contained within the integrative structure of complex reflexes occurring at this level, and that they are wholly subordinated to the specific features of these reflexes (6). We observed a close mutual relationship between heart rate and breathing changes and the nature of behavioral effects in response to stimulation of both the CN and PH. Opposite participation of the CN and the PH in the brain's integrative activity can explain the distinct differences observed in the structure of changes occurring in heart rate and respiration. In response to CN stimulation these changes develop together with obvious, emotionally saturated behavior, and they are distinguished by great amplitude, constancy of direction, and long duration, as well as by closer correlation between the reaction's individual components, in comparison with what is observed with stimulation of the PH. Fragmental, emotionally impoverished behavior is typical of the latter.

The functional heterogeneity of different portions of the CN relative to heart rate and respiration can be explained by the somatotopic organization of its associations. In particular the caudal divisions of the CN are associated more closely with thalamic nuclei, while its rostral divisions are associated more with the cortex (4).

The individual features of behavioral responses as well as changes in heart rate and respiration can be explained in light of facts attesting to participation of the CN in afferent synthesis on one hand (2,3,15) and in effector motor reactions on the other (15). Electrostimulation probably activates mainly those structures which participate in sensory information processing, imitating afferent impulsation. Further development of the response and support to it by the autonomic nervous system involve operation of the evolved structural-functional system, depending entirely on the type of nervous activity. This is confirmed by the similarity of our results to data acquired from research on motor reactions to adequate stimulation of analyzers (10), where the nature of breathing changes was found to depend on the type of nervous activity exhibited by the animal. Moreover the breathing changes we observed in response to stimulation of the CN occurred earlier than did changes in heart rate; as with the response to adequate stimuli, these breathing changes arose simultaneously with orientational behavior.

Motor reactions and the tachycardia accompanying them arose in response to suprathreshold stimuli following a longer latent time. When the effector

elements of the CN were activated, change in cyclic autonomic functions such as cardiac activity and respiration occurred mainly due to change in the number cycles per unit time, and not the quality of the individual cycles. In this case the most typical combination was that of faster heart rate and faster breathing, with no change occurring in breathing depth. It was noted earlier that cardiovascular and respiratory reactions accompanying motor responses for which the CN is responsible are similar to changes arising in conjunction with fragments of spontaneous motor behavior of identical nature (11).

Conclusions

1. The caudate nucleus has a regulatory influence on cardiac activity and breathing. The mechanisms of these influences are subordinated to the specific features of behavior shaped with the participation of this nucleus.
2. The caudate nucleus has different effects on cardiac activity and respiration. Deeper changes occur in heart rate when rostral divisions are activated, while deeper breathing changes are typical of stimulation of the caudal division.
3. The effects the caudate nucleus has on cardiac activity and respiration differ from hypothalamic effects, which can be explained by differences in the way these structures participate in behavior integration. The correlation between individual components is closer with hypothalamic reactions.

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PHYSIOLOGY

EXISTENCE OF BIOPLASM ASSERTED

Moscow TEKHNIKA I NAUKA in Russian No 5, 1979, pp 18-19

[Article by V. Inyushin: "Bioplasm is Reality"]

[Text] "Bioplasm: Myth or Reality?" was the title of an article published in our journal last year (see TEKHNIKA I NAUKA, No 3, 1978). In this issue Professor V. Inyushin, chairman of the Biophysics Department at the Kazakh State University and chairman of the Bioenergetics committee affiliated with the Kazakh SSR Council of Scientific and Technical Society, continues this subject. He is disputing some assertions put forth in the article "Bioplasm: Myth or Reality?" and adducing his own arguments which confirm the existence of bioplasm. Perhaps some readers will not find them sufficiently substantiated, but the scientific dispute precisely serves the purpose of verifying the conclusiveness of arguments adduced by the disputing parties.

History of science provides many examples when an outside view of a specialist in one of its branches was beneficial for another branch. It is good, of course, but everything should always have its limits. It is common knowledge that, for example, without a deep knowledge of biological sciences it is impossible to evaluate correctly how promising some ideas and hypotheses in natural science will be.

We will remind the reader that the level of theoretical and experimental equipping is considerably higher in physics and chemistry than in biology. It is not accidental that biology cannot withstand the onrush of reductionist ideas generated by physicists and chemists. There is a threat that biological knowledge will lose its independence.

Let us start with mitogenetic rays. Both M. Vol'kenshteyn and N. Klimontovich deny their existence (see TEKHNIKA I NAUKA, No 3, 1978). The logic of their reasoning is much like this: since physical methods are impotent to detect such weak luminous fluxes, then the rays do not exist! And even if they had existed, they would not have been able to affect considerably the physical-chemical processes in the living cell. It is impossible thermodynamically. Is it, however, that simple in actuality?

Mitogenetic rays were discovered by the Soviet scientist A. Gurvich by means of the biological detection method as early as 1923. This method is as follows: radiation which appears with mitosis (cell fission) goes through the quartz glass and is intercepted by other cells which proceed from dormancy to fission. Cells have proved to be susceptible to the radiated photons.

Thousands of investigations conducted by Professor A. Gurvich's school and his followers in our country and abroad, have confirmed the existence of biologically active radiation. The well-known Soviet biophysicist Professor B. Tarusov, founder of the Moscow State University Biophysics Department, did not question the existence of mitogenetic rays. By means of photomultipliers and amplifying technology, he and Professor S. Konev have registered ultra-weak light radiations of living cells in the ultraviolet and visible parts of the spectrum.

Several papers at the International Congress on Biophysics (Moscow, 1972) were devoted to mitogenetic radiation. Information on mitogenetic rays has been included in the Great Soviet Encyclopedia (3rd edition) and RUKOVODSTVO PO TSITOLOGII ["Manual of Cytology"] (Izd. "Nauka").

An article on remote cell interaction in tissue culture by means of ultra-weak radiations was published in DOKLADY AKADEMII NAUK SSSR ("DAN SSSR," 236, No 4, p 1007). Its authors are scientists from the Institute of Physics of the Belorussian SSR Academy of Sciences. V. Kaznacheyev's series of studies is well known too; these studies have effectively shown the informational role of ultra-weak radiations, including mitogenetic radiation.

In addition, the Biophysics Department of the Kazakh State University has developed a simple method for registering mitogenetic radiation on photoemulsion (author's certificate No 512452). Pictures of actively growing corn and barley roots were obtained without an immediate mechanical contact with photoemulsion in mitogenetic rays in complete darkness. Dead plants do not possess this quality. The root itself claims unequivocally that mitogenetic radiation exists and has many characteristics which are unusual from the standpoint of optics. Facts are persistent, and they should be taken into consideration.

All this suggests that our opponents are familiar with the current state of this problem superficially. That is why the aforementioned authors react negatively to the hypothesis that the existence of bioplasm is possible.

At present the hypothesis of bioplasm is being successfully developed not only in our country, but in other countries as well. The interest in it is not accidental. It has resulted from the accumulation of vast actual material on the role of delocalized particles in the living organism and on semi-conductive properties of biomolecules and cell membranes. It is absurd to deny the presence of semiconductive properties in organic structures.

Hundreds of articles and dozens of monographs deal with this problem (see, for example, L. Boguslavskiy and A. Vannikov, ORGANICHESKIYE POLI'PROVODNIKI ["Organic Semiconductors"], Moscow, "Nauka", 1968). They demonstrate the existence of semiconductive properties in organic structures.

Solid-state physics uses the concept of "semiconductive plasm." While studying the semiconductive properties of biological structures, it is natural to assume that they also have plasm. How does it differ, however, from the plasm of the inorganic world? First and foremost, by its orderliness, in our opinion. This point of view has been approved by the Romanian Academician (Ye. Makovskiy), who wrote about it in his book "Nature and the Structure of the Living Matter" (it has been published in Russian with a review by the most prominent Soviet scientists, in particular Academician A. Oparin). Thus, it says: "The problem of biological plasm attracts attention...The name of bioplasm shows that the fourth state of the matter, i.e., plasm, exists in living organisms, as well as in semiconductors" (p 191), or: "...biostructured matter forms 'biostructure' which, along with the existent molecular matter, is a carrier of 'bioplasm' and generates the emission set that represents 'the material structure of the biological field.'"

The Polish national conference on bionics was held in Warsaw in 1977. I was among its participants and heard there a brilliant paper by Polish Professor V. Sedlak on bioplasm. He also draws an analogy between semiconductive plasm and bioplasm and believes that many biological phenomena can be convincingly explained by the new hypothesis. This hypothesis helps understand numerous facts which cannot be interpreted on the basis of physical-chemical notions alone. Here are a few of such problems. The therapeutic method of acupuncture and the concept of the so-called biologically active points on the skin of man and animals are well known. This type of therapy has been practised for a long time, and the interest in it is not disappearing but, on the contrary, is increasing, particularly in the last few years. However, there has been yet no theory of the origin of the astonishing ties between the points on the skin and internal organs. Traditional interpretations prove to be impotent when they deal with facts accumulated by experience. Meanwhile, the concept of bioplasm makes it possible to find new ways of explaining the phenomenon of acupuncture. The suggested hypothesis also explains convincingly Hill's experiments on the liberation of heat during the destruction of living tissues as well as the bursts of degradational radiation during the effect of extreme factors on cells which have been registered by A. Gurvich and B. Tarusov.

The concept of bioplasm also offers a new approach to the study of biorhythms. Professor N. Agadzhanyan, a well-known Soviet biologist, writes about it in his book ZERNO ZHIZNI ["The Seed of Life"]. He considers it necessary to develop this concept, inasmuch as it allows for a better understanding of the connection between biological processes and cosmic phenomena.

One cannot but mention the Moscow State University Professor N. Kobzev, a well-known theorist in thermodynamics, who writes in his book TERMODINAMIKA MYSHLENIYA I INFORMATSII ["Thermodynamics of Thinking and Information"] that it is impossible to cognize the deep processes of life on the molecular level. He draws a conclusion about the presence of the system of elementary particles in the organism.

Not long ago in his article published in LITERATURNAYA GAZETA, the prominent Soviet physicist Academician I. Lifshits wrote on the important role of ultra-weak radiations in the life of organisms. Moreover, he called for serious attention to the studies of radiations from the brain (the phenomenon of telepathy). Lifshits also cited the statements of another most prominent theoretical physicist--I. Tamm. Consequently, there is no unanimous opinion among the physicists about the "mythical nature" of weak electromagnetic radiations characteristics of biological objects.

Now let us summarize. Modern biology needs an entirely new approach to a number of phenomena, or, in the words of the Nobel prize winner (A. Sent-D'erd'i), "something very important, a whole dimension, without which an approach to these problems cannot be found, is apparently missing in our present mode of thinking" ((A. Sent-D'erd'i) BIOENERGETICS, Moscow, Fizmatgiz, 1960, p 23).

It is indisputable that the affirmation of the new truth in biology will not be easy and will take many years. The concept of bioplasm has its own thorny path, as does any other new idea in science.

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DESTRUCTIVENESS OF WHEAT STEM RUST

Alma-Ata IZVESTIYA AKADEMII NAUK KAZAKHSKOY SSR in Russian No 3, 1979 pp 9-11

[Article by S. A. Abiyev, Kazakh SSR Academy of Sciences Institute of Botany]

[Text] Wheat stem rust causes profound pathological changes in the host plant's general metabolism. Owing to this, infected plants experience a decrease in ear grain content and in the absolute weight of seeds, and deterioration of grain qualitative composition. A proportion of the seed, of diseased plants lose their capacity to germinate, and sprouts from such seeds are more susceptible to various phytopathogenic fungi. All of these effects of the pathogen lead to a dramatic decline in the wheat yield.

Stem rust (caused by *Puccinia graminis* Pers.) is a widespread wheat disease. In the Kazakh SSR its range embraces mainly the northern grain-growing oblasts. In the republic's southeast it develops in small foci in the suburban rayons of Alma-Atinskaya and Taldy-Kurganskaya oblasts, predominantly on irrigated land.

The destructiveness of stem rust was studied with Kazakhstanskaya 126 spring wheat planted on commercial farm fields and in experimental plots. Transpiration intensity was determined by the weight method, and photosynthesis was determined from the quantity of carbon dioxide absorbed by plant leaves (1). The protein content of wheat grain was computed from the amount of ammonium released upon combustion of the grain in sulfuric acid, the carbohydrate concentration was determined quantitatively, the cellulose content was determined from the amount of crude cellulose corrected for absolutely dry matter, fats were determined from the fat-free residue remaining after extraction, and ash was determined by combustion of the grain in air (2). All numerical data were subjected to dispersion analysis.

Table 1 describes the destructiveness of wheat stem rust. We can see from these data that the transpiration rate of sick plants is somewhat higher.

This is associated first with appearance of numerous ruptures in the epidermis of diseased plants--uredopustules. As an example according to Rusakov (3) stem rust can form up to 1,500 openings on one wheat stem and up to 100 on each leaf. Owing to this, purely physical evaporation of water rises. Second, when the concentration of carbohydrates in guard cells decreases (due to their consumption by the fungus), the water retention capability of stomata declines (4).

Photosynthesis is significantly inhibited in diseased plants. While healthy plants assimilate 14.5 mg CO₂ per hour through 1 dm² leaf area, sick plants with 45 percent of their area infected assimilate only 9.21 mg CO₂ owing to reduction of the assimilating surface of leaves due to its occupation by uredopustules.

Table 1. Effect of Stem Rust on Wheat Plant Productivity and Sowing Qualities of Wheat Seeds

Вариант (интен- сив- ность по- ражения, % (1))	Интенсив- ность тран- спирации, г/дм ² в час (2)	Интенсив- ность фото- синтеза, мг CO ₂ /дм ² в час (3)	Урожай- ность ц/га (4)	Вес 1000 зе- рен, г (5)	Озернен- ность колоса, шт. (6)	Вско- жесть семян, % (7)	Поражен- ность всхо- дов патоген- ными гриба- ми, % (8)
0	7.03	14.50	26.3	40.21	37.10	93.30	3.50
15	—	—	25.8	37.15	38.11	98.51	3.80
45	7.84	9.21	17.0	30.08	31.40	97.22	7.00
85	—	—	4.5	12.00	17.50	83.63	38.51

Key:

1. Variant (infection intensity, %)
2. Transpiration intensity, gm/dm² per hour
3. Photosynthesis intensity, mg CO₂/dm² per hour
4. Yield, c/ha
5. Weight of 1,000 grains, gm
6. Number of grains per ear
7. Seed germination, %
8. Sprout infection by pathogenic fungi, %

Rust fungi cause profound pathological changes in the host plant's general metabolism (5,6). Besides changes in photosynthesis and transpiration, sick plants experience change in the intensity of respiration and in the qualitative aspects of this process; outflow of assimilated compounds into other organs is delayed, and coordination of the enzymatic apparatus is disturbed. As a result of such deviations many physiological and biochemical processes in the plant organism are impaired. Rust consumes a significant proportion of the host plant's assimilated compounds to form mycelium and an enormous quantity of uredospores and teleutospores (up to 1.25 trillion uredospores per hectare). The latter consist of up to 20 percent protein, as much fats, and about 30 percent carbohydrate (7).

All of these effects of rust fungus severely emaciate the sick plant, reduce the number of grains per ear, and decrease the absolute weight of seeds,

which leads to an overall decline in the yield of infected fields (see Table 1). The disease also has an indirect reflection upon the future yield: Seed germination declines, and sprouts from such seeds are more readily infected by various phytopathogenic soil fungi. Death of sick sprouts results in thinner wheat stands.

Table 2. Effect of Stem Rust on Wheat Grain Chemical Composition (Percent Absolutely Dry Matter)

Вариант (1)	(2) Белки	(3) Углеводы	(4) Жиры	(5) Клетчатка	(6) Зола
(7) Здоровые растения	16,3	75,6	2,1	1,9	2,1
(8) Пораженные растения (и. в. — 50%)	16,0	76,0	1,1	3,1	3,3

Key:

- | | |
|------------------|--|
| 1. Variant | 5. Cellulose |
| 2. Proteins | 6. Ash |
| 3. Carbohydrates | 7. Healthy plants |
| 4. Fats | 8. Infected plants (infected surface area--50 %) |

Stem rust has a negative effect on the chemical composition of wheat grain, reducing the quantity of proteins, carbohydrates, and fats, and increasing the ash and cellulose content (Table 2).

After absolute weight decreases by more than 50 percent the grain cannot be used as seed grain, nor is it marketable (8). We should also consider the fact that such puny grain is easily removed with straw by the air current in the harvesting machinery during harvesting, and that it is sifted out with wastes during cleaning and sorting.

Thus the research results and published data indicate that stem rust is an extremely detrimental wheat disease. The extent of the destruction it causes is the product of the sizeable proportion of plants infected: The disease infects all plants without exception, and in favorable years it affects tremendous territories. This is why control of rust wherever it develops significantly is one of the measures aimed at increasing the harvest of wheat--a highly valuable food crop.

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THE STATE AND PERSPECTIVES OF THE BIOLOGICAL METHOD OF DEFENDING PLANTS AGAINST ILLNESSES

Moscow ZHURNAL OBSHCHEY BIOLOGII in Russian No 3, 1979 pp 325-332

[Article* by M. V. Gorlenko]

[Text] Various sides of the biological defense of plants against illnesses are examined: the use of antibiotics and problems arising in conjunction with this measure; the use of preparations containing the live rudiments of microorganisms--antagonists; cross protection of plants from illnesses by way of the preliminary processing of them with weakened cultures of pathogens; a change of the biocenosis in the direction of a suppression of pathogens at the expense of the preferential accumulation in the soil of the antagonists of the phytopathogens; measures are examined with the help of which this is achieved.

Problems are considered which confront specialists devising a biological method for the defense of plants against illnesses.

The wide use of pesticides for the defense of plants against diseases and pests often leads to the pollution of the external environment, as well as to the pollution of the products of nutrition and fodder with the residues of pesticides. This leads to the necessity of elaborating other ways to defend plants. Among them the biological method occupies a large place. The problem of the biological defense of plants against illnesses is diverse. The speech in the present article is about various of its dimensions.

Attempts to use the phenomenon of antagonism in the world of microorganisms for the defense of plants have the most long-standing history. It began from the same point as in medicine with the use of antibiotics

*Report read at the session of the Department of General Biology of the USSR Academy of Sciences, 5 December 1978.

produced by various kinds of microorganisms and higher plants. If one proceeds through a series of experiments and recommendations, not having found in the end any application in practice, then one may admit that for use in agricultural production of our country three biological preparations are recommended and in one or another quantity are produced: phytotheriomycin for the struggle with the seed infection of pulse crops by bacterioses and with the bacteriosis of the mulberry tree; trihotsetin for the struggle with mildew fungi (especially for the struggle with mildew of cucumbers in greenhouses); arenarin for the struggle with bacterioses of tomatoes (Sazonov (ed.), 1978). A series of antibiotics, although they proved entirely effective versus several diseases of plants, were not allowed for use because they are used in medicine. The speech concerns itself mainly with streptomycin, including industrial streptomycin. It seems to me, that such a prohibition in several cases bears a formal character. For example, the works of A. A. Oganessian (the Armenian Institute of Plant Protection) showed that streptomycin allows us to solve the question about the struggle with bacterial wildfire of tobacco. However, permission for its wide use was not given. Meanwhile the conditions of cultivation of tobacco are such, that between the sowing of treated seed and the obtaining of the tobacco product a time transpires, sufficient for the decomposition of the preparation in plants. Besides that, the process of processing of the raw material and smoking itself promote the decomposition of the residues of the antibiotic.

One should point out, that in the United States streptomycin is applied with success for the struggle with pine rust (*pinus strobus*) and bacterial blight of fruit trees and in India, with bacterial canker of citrus trees. Let us add that other methods of struggling with these illnesses did not give the proper effect.

Antibiotics are widely used for the struggle with diseases of plants in Japan. For example, every year up to 19,000 tons of kasugomycin is produced here, effective against rice pituitariosis--one of the most harmful diseases of this crop in our country. Industrial production of antibiotics for the needs of agriculture has been started in Czechoslovakia, Hungary and other countries. Many of them were tried with success in the USSR (Petrukhina, Butsevich, 1972). Thus, the possibility of the wide use of antibiotics in agricultural production is real and nothing justifies their slow introduction and the limited number of investigations into this problem.

However, the finding of a new effective antibiotic is only the beginning. At once there arises a number of problems which it is necessary to solve before the preparation can be recommended for production. First of all there is the elevation of productivity of the producer. Here one should note, that the hand of the geneticists and breeders did not touch or almost did not touch the producers of antibiotics recommended for use in agriculture. The presence in the composition of the USSR Academy of

Sciences of institutes occupied with the problems of genetics might be able to strengthen such a type of investigation and aid in the creation for agriculture of more effective antibiotics.

One should note that antibiotics render not only a therapeutic action and an action of suppressing pathogens. As it turns out, several antibiotics are able to activate the defensive reactions of plants, including the promotion of the formation of phytoalexins. In the experiments of M. Mustafa and Yu. T. D'yakov (1979) streptomycin, ristomycin, polymyxin and chloramphenicol elevated the content of the phytoalexin rishitin in the tissues of susceptible sorts of potatoes to the level of the resistant sort after their infection with the virulent race of the causative agent of late blight. Various antibiotics acted variously. Chloramphenicol activated the system of the synthesis of rishitin in the plant, promoting in response to infection by the pathogen the formation of large quantities of this antibiotic. Ristomycin elicited an intensification of the loss by the sprouts of the parasite spore of substances inducing the accumulation of rishitin. There is analogous information in the foreign literature. It is important to note that antibiotics here act in concentrations much less than are lethal for the spores of pathogens (Blumenbach, 1968; Voros et al., 1957). The promising future of further research in the direction mentioned above is obvious.

Another means of the biological struggle with infectious diseases of plants is the use of preparations containing live rudiments of the antagonist of phytopathogens. Here two preparations the most highly elaborated are used--trichodermin and the preparation containing oidia of the fungus *Peniophora gigantea*--the antagonist of the causative agent of root sponge of softwoods.

Trichodermin--a preparation of the fungus *Trichoderma viride* and similar species--is used mainly for the struggle with soil pathogens. To this fungus and to trichodermin is devoted a voluminous literature in practically all the countries of the world. In our country several forms of trichodermin have been developed, designated by various numerals. A portion of them can be prepared directly on farms, others by centralizing deep cultivation of the fungus. The methods of their preparation and means of application are described by N. S. Fedorinchik (1971, 1976) who did much for the elaboration of methods of application of trichodermin in the defense of plants from illnesses. The laboratory regulations of the deep cultivation of the fungus are proposed by the All-Union Scientific Research Institute for microbiological means of plant protection and bacterial preparations.

A series of important experiments in the application of trichodermin for the protection of vegetable crops were carried out in Byelorussia by A. I. Kustova (1972) under the leadership of N. Z. Dorozhkin.

The massive preparation and application of trichodermin required the solution of a series of questions linked with the biology of the fungus and its interrelationship with soil microbes. A part of them are not yet solved.

First of all a study of the fungus itself carried out by A. N. Likhachev (1974) showed its heterogeneity in the character of its sporulation in culture, and along with this in its antibiotic activity. The strains which were the most highly sporulating proved to be the most active. Therefore preparations will be effective with a predominance in the population of exactly such a type of strain. The various levels of activity of trichodermin in a number of cases is probably linked with the fact that the heterogeneity of the population of fungus was not taken into account. The study of the structure of the population of various species of trichoderma must continue. Here the institutions of the USSR Academy of Sciences can do much. They must enter into the work for creating more active strains, using induced mutagenesis as well.

The second important problem linked with the use of trichodermin is the viability of the fungus in the soil after the introduction there of the preparation. The matter is thus, that not only the one time action of the fungus is important, but also its viability, its further accumulation and active action in the soil. While it is well known that this will take place in soils rich with organic matter, normally moistened and well heated. However, the condition of the soil is only one side of the matter. It is important to know how the interrelationships of the fungus introduced into the soil take shape with the local microbial population of the soil. In conjunction with this arises the question about the greater or, on the other hand, lesser effectiveness of local or imported races of the producer of trichodermin. Probably it is impossible to resolve this matter simply, but it depends on the composition of the microflora of the soils on which trichodermin is applied. Local phytopathogens could be resistant to local races but on the other hand local races are adapted to their climate. Local phytopathogens are not adapted to imported races and therefore would be more easily suppressed by them. However imported races may "work" weakly in an unusual climate for them. In our view, the optimal solution of the question is the use of imported races of producer with wide possibilities of "working" in various climatic conditions. Probably it will be necessary to create such races artificially. In conjunction with what has been said, besides knowledge about the effectiveness of action of one or another preparation, also important is information about the ecology of its producer, that is, a good theoretical foundation, without which there will be much empiricism, many unexplained failures, and in conjunction with this many obstacles for the wide application of biological preparations.

The second biological preparation containing live rudiments of the antagonist and finding a wide application in practice is the preparation containing oidia of the fungus *Peniophora gigantea*. They use it for the treatment of stumps infected with the causative agent of root sponge--one of the most dangerous parasites of softwoods in many countries of the world, including the USSR.

At a recent conference of the countries of the Council of Economic Mutual Aid and Finland on the struggle with root sponge the results of the application of the mentioned preparation were summed up (Vasilyauskas, 1978). Substrata were developed for the accumulation of fungus and the methods of its massive application. The participants of this conference--prominent erudite forest pathologists--spoke about the superiority of the biological protection of softwoods from root sponge over the chemical protection of softwoods. Now genetic investigations of the fungus-antagonists are carried out, and the presence in it of two differing populations has been established--one of them suitable for the protection of spruce, the other for the protection of pine.

In the USSR S. F. Negrutskiy (1975), A. P. Vasilyauskas and B. Yu. Kozhemekene (1972) et al. studied the possibility of the use of *Peniophora gigantea* for the struggle with root sponge. The results of their work showed the excellent effectiveness of the mentioned preparation. For its wide use in our country it was necessary to organize the industrial production of a suspension of oidia of *P. gigantea*. Production of such a kind is set going, for example, in England, where this preparation for the struggle with root sponge is used in all the state pine forests. It was necessary also to study the genetic diversity of the fungus-antagonist, which essentially up to that time had not been carried out in the USSR. Probably one should move from the search for active strains to a heightening of the activity of those already possessed, using the experience of the work with medicinal antibiotics. It seems to me, that this is one of the important problems, in which the Institute of General Genetics of the USSR Academy of Sciences and especially the All-Union Scientific Research Institute of Genetics and Selection of Industrial Microorganisms should join in solving. There are a series of unclear questions linked with the biology of the fungus-antagonist. Probably, this is a problem for the institutes and laboratories of the USSR Academy of Sciences linked with a study of the forest.

I have brought forward information only about two preparations with live rudiments of an antagonist. The possibilities of the creation of other similar preparations are far from exhausted, as are the forms of application of antibiotics for the protection of plants from illnesses. For example, E. F. Solovey (1974) illustrated the possibility of the destruction of bacterial swellings on grapes with the help of a paste containing an antibiotic, the product in the raw state of the fungus *Penicillium martensii* var. *moldavicum* Solovei with fillers--grease or vaseline.*

*Phytopathogenic organisms can adapt to antibiotics. This question is not touched upon in the present article.

For the struggle with phytopathogens not only fungi-antagonists are used. Abroad, for example, a biological method of struggle with so-called champignon rust is being introduced with the help of bacteria-antagonists from the genus *Pseudomonas* (Nair, Fany, 1972).

The change of the biocenosis in the direction of the suppression of soil pathogens related to the biological struggle. Possibilities here are varied: the accumulation of antagonists by way of the selection of crops in crop rotation, the introduction of appropriate fertilizers, the maintenance or, on the other hand, the removal of soil fungistasis.

The most long-standing information here is available in relationship to cotton and wilt. Still in the 1930's A. I. Solov'yeva (1940) showed that the observance of cotton and alfalfa crop rotation allows one to restrain the development of wilt on account of the accumulation after 3 years' standing of the microsclerotia of the causative agent of the disease. Recent research of a group of Leningrad and Uzbek phytopathologists showed that after 3 years of alfalfa the number of viable microsclerotia decreased in the soil by roughly six times. Still more effective is the use of fields infected with wilt which are discontinued for cotton for a crop of rice, after which the soil almost completely is freed from the infectious rudiments of the causative agent.

The study of the antibiotic activity of the soil in the Leningrad Oblast showed that fungi and actinomycetes-antagonists accumulate the most intensively in fields sowed with peas and clover (Kamyshko et al., 1976). One may bring forward many such examples. One may think, that the selection of crops in crop rotation fields allows one to change the biocenosis which has arisen in the soil and to accumulate there the necessary complex of microorganisms. Several fertilizers, mainly nitrogenous ones, also act in an exemplary fashion. For example, according to data of the Uzbek phytopathologists ammonium sulfate and calcium cyanamide to a well known degree hinder the accumulation of the causative agent of wilt in the soil and increase the yield (Mirpulatova et al., 1978).

The regulation of the rotation of crops, just as the introduction of fertilizers in one or another level regulating the accumulation in the soil of infectious rudiments of soil pathogens, is linked with the phenomenon of fungistasis. Its essence consists in the fact that many resting stages of phytopathogenic fungi lying in the soil an indefinitely long time do not germinate (remain in a condition of protracted rest) and consequently, cannot be sources of infection. Without entering into the essence of this phenomenon, I will only point out, that the destruction of fungistasis or, on the other hand, the maintenance of the rudiments of the phytopathogens in a condition of rest is a powerful factor in the defense of plants from soil pathogens. As the director of the laboratory of soil pathogens of the All-Union Institute of Plant Protection A. A. Benken (1975) wrote: "It is necessary to learn how to rationally use

and stimulate the natural protective strengths of nature in the struggle with the most important diseases of agricultural plants transmitted through the soil." This is being achieved by various paths. For example, the introduction into the soil of green manure, the green mass of catch crops, delays the germination of the resting structures of phytopathogens (Marshunova, Muromtsev, 1975). On the other hand, the introduction into the soil of sodium pentachlorophenate as well as manure or mineral nitrogen stimulates the germination of resting structures, which in the absence of susceptible plants promotes the death of the mycelium of germinating sclerotia.

One should say that phytopathogenic microorganisms hold out well on plant residues, however only until their decomposition. This process accelerates upon accumulation in the soil of cellulose destroyers. In essence this is also a biological means of cleaning the soil of infectious rudiments. The accumulation in the soil of the mentioned microorganisms is achieved by the enrichment of the soil with nitrogen, the sowing of nitrogenfixers etc.

In the problem of the cleansing of the soil from the rudiments of phytopathogens there is still much that is unclear or developed inadequately. The development of these investigations is one of the most important problems of contemporary phytopathology. Especially acutely the question regarding the struggle with soil infection stands linked with the intensification and specialization of agricultural production with the saturation of crop rotation with crops of the same name.

One should also relate so-called cross protection to biological means of protection of plants from illnesses. Its essence consists in the fact that the primary inoculation of plants with weakly pathogenic or non-pathogenic microorganisms or such races of pathogens leads to resistance or weak susceptibility of those same plants upon infection with virulent races or species. The facts of such cross protection are proven both for obligate and for facultative parasites. An excellent review of the literature about cross protection of plants is given by E. N. Ksendzova and S. L. Tyuterev (1978). I will only point out that the authors of the review, thinking that the presence of cross-protection of plants from a series of fungi is without doubt, note the insufficient elaboration of the nature of this phenomenon. They think that the solution of this question lies in the province of the knowledge at the molecular level of the mechanisms by which plants obtain resistance.

Cross protection, often called vaccination, found application in the practice of the protection of tomatoes from tobacco mosaic virus (TMV) both in our country and abroad (work of All-Union Institute of Plant Protection and the Institute of General Genetics of the USSR Academy of Sciences). In Holland a weakly pathogenic mutant of TMV is used, obtained by way of the influence of nitrous acid. In the Soviet Union for vaccination a natural weakly pathogenic strain of TMV is used

isolated in natural conditions from tomato plants by Yu. I. Vlasov and T. A. Red'ko (1971). In the Institute of General Genetics of the USSR Academy of Sciences a series of spontaneous attenuated mutants used with success for the vaccination of tomatoes were obtained (Surhov et al., 1978). All these strains underwent production verification in greenhouse farms of various rayons of the Soviet Union (see, for example, Ogarkova, 1978).

Tomato plants vaccinated with weakly pathogenic strains of TMV obtained by the All-Union Institute of Plant Protection practically entirely are protected from fruit necrosis, streak, deforming mosaic. For practical application methodological instructions were drawn up, published by VASKhNIL (Vlasov, Shcherbakova, 1977). The vaccination of the potato with a weakly pathogenic strain of x virus was successfully carried out (Romanova, 1978).

The vaccination of cotton against wilt with weakly pathogenic races of the causative agent of the disease was rather successfully tested. In any case the possibility in principle of decreasing in such a way the susceptibility of cotton to verticillium wilt was proved (Sudorova, 1978). Resistance after vaccination is linked with the formation of phytoalexins, and the duration of the effect of vaccination depends on how long the phytoalexins arising as a result of the introduction of the vaccine are not destroyed.

In cross protection of plants there are still many points that are unclear. They relate not only to knowledge of the mechanisms of resistance arising as a result of vaccination, but also to the elaboration of effective methods of vaccination useful for practical application, means of preparation of vaccines and many others. As was pointed out, cross protection of tomatoes from TMV when they were grown in greenhouses obtained wide application. Probably, exactly against diseases of enclosed soil, vaccination can obtain practical application. I will mention black stem of cucumbers, scab of tomatoes and several others. Not only is the practical side of the matter important, but also the elaboration of a theory of the question, the knowledge of the mechanisms of the resistance obtained. The participation of the academic institutes in this work will be very useful and will accelerate a solution of the problem.

Now regarding several of the most important problems. First of all the search for new antagonists and parasites of a second order must continue, for it will be possible to use them for the struggle with phytopathogens. The promising future of this is obvious, and the possible resources are far from exhausted. For example, a study of antibiotic substances of microphilic fungi (parasites of hymenomycetes and other fungi) showed that they form antibiotic substances which are also active against phytopathogenic microorganisms (Sudorova et al., 1977). In the future one should make an attempt to create biological preparations on their basis.

One may still find many microbes active against phytopathogens among soil fungi. Thus, a study of the antibiotic substances of fungi isolate from soils taken under vineyards led to the discovery of antagonists of the causative agent of bacterial canker of grapes. I already pointed out that the paste, destroying swellings on grapes, was made on the basis of an antibiotic produced by one of the fungi found under the soil of vineyards (Solovey, 1974; Gorlenko, Solovey, 1975). We note that the problem of the struggle with bacterial canker of grapevine is one of the basic ones in viniculture in our country.

Searches for new antagonists must be carried on in the future, too. The Institutes of Microbiology and Botany of the USSR Academy of Sciences and union republics together with the Institutes of Agricultural Microbiology of the V. Lenin All-Union Academy of Agricultural Sciences and the Institutes of Antibiotics of the USSR Academy of Medical Sciences can be occupied with them.

The ecology of producers of antibiotics and of other biopreparations is insufficiently studied. Without this knowledge it is necessary to act without adequate scientific basis in recommending the use in practice of one or the other biological preparation. For example, repeated efforts were made to suppress rust fungus with the help of a second order parasite *Darluca filium*. However only in conditions of high humidity of the air (in the Kolkhidskaya lowland) was it possible to attain a high effect from application of the mentioned fungus. A one-time spraying with a suspension of conidia of *D. filium* against corn rust gave an effect, equal to a spraying 5 times with the preparation TMTD (Dorovskaya, 1969). Consequently, the mentioned fungus "works" well in high humidity and only in such conditions is it possible with its help to suppress the development of rust fungi. If it were possible with the help of selection to obtain less moisture-loving strains of *D. filium*, then this would allow us to widen the sphere of its application for the biological struggle. One can say the same about other parasites of the second order too: about the parasite of mildew fungi--*Cicinobolus cesatii* and about the parasite of rust fungi--*Tuberculina persicina* etc. Up to this time work was carried out with natural strains. However, in the first place, the heterogeneity of parasitic fungi in virulence with relation to the host is well known, and, in the second place, the ecological possibilities of natural strains are often limited and depend on those conditions in which they existed in nature. In both cases bringing natural strains to the necessary specifications is possible.

When any biological preparation appears, people try to use it for the struggle with various pathogens. This does not lead to the proper effect in all cases, and in the end leads to a discrediting of the preparation.

Several years ago the high effectiveness of trikhhotetsin in the struggle with phytopathogenic fungi was revealed, after which people began to

recommend it for the protection of plants against various illnesses of plants including cotton wilt. In the last case it was revealed that the effect was inconstant. As was established later, this was linked with the fact that in the soil trikhotetsin was rapidly destroyed by soil microbes (Sidorova, 1971). The matter was as follows, that the producer of trikhotetsin, the fungus *Trichothecium roseum* link, does not live in the soil and therefore its antibiotic was not directed toward the protection from soil microbes. However, it gave an advantage to the fungus when it developed on plant residues and live plants. Therefore in the struggle with parasites of the surface parts of plants the effect from the application of trikhotetsin proved to be high. Here it found application. It might have been possible to foresee the situation created earlier, if the ecology of the producer had been taken into consideration.

One may admit that with us many are occupied with searches and attempts to use one or another biological remedy of plant protection. However, the theoretical side of the affair is forgotten or people are insufficiently occupied with it. However it is well known that without a good theory there cannot be a sufficiently effective, stable practice, too.

In the present report I wanted, first, in general outline to show the state of the problem as a whole, secondly, to point out questions not thoroughly worked up, and finally, thirdly, to call academic and other establishments to take part in the solution of questions which without them cannot be resolved or will be resolved extremely slowly.

Unfortunately, in the system of the USSR Academy of Sciences there is not an establishment, in which might be concentrated the thorough study of fungi--one of the basic antagonists of phytopathogens. Some establishments occupy themselves with taxonomy, or rather floristics, others with various questions of the physiology and biochemistry of fungi, a third group with questions of biology, partly ecology of individual groups etc. There is not a unifying center. Meanwhile, the useful and harmful activity of fungi is such that it requires their detailed study, and in conjunction with this it is necessary to create an organizing and scientific center in the system of the USSR Academy of Sciences.

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DEVICES FOR SYNCHRONIZATION OF DIGITAL MEASURING APPARATUS WITH BIOLOGICAL SIGNALS

Kiev FIZIOLOGICHESKIY ZHURNAL in Russian No 1, 1979 pp 93-95

[Article by A. M. Sokolyuk, Kiev Orthopedics Institute]

[Text] Digital measuring instruments, which can be used to obtain information concerning parameters of the body's vital activities in direct digital form, are presently enjoying increasingly greater use in biomedical research. However, the industrially produced instruments are ill-suited to the conditions of biomedical research, since in most cases they cannot be started up at the needed moment of research directly by the biological signals picked up by sensors. Owing to a number of shortcomings (hysteresis, low input resistance, low sensitivity, high requirements on steepness of the forward edges of the input signals, poor protection against interference), the synchronizers employed in such cases (2-5) make coordination with the source of the biological signals difficult.

I have designed and used synchronizers for various biological signals devoid of these shortcomings, making it possible to control both digital measuring instruments and various supplementary devices as required by the concrete research conditions.

The principle of operation of the proposed devices is as follows: A voltage difference is obtained at the output of a comparator in which the useful signal at one of the inputs is compared with a reference voltage at the other input. The comparator is represented by an operational amplifier consisting of a K1UT401B integrated microcircuit without external negative feedback. To increase the loading range of the integrated operational amplifier I added a key-operated power amplifier based on a bipolar transistor. A pulse with positive or negative polarity is formed at the output of the operational amplifier depending on the input of the operational amplifier (inverted or noninverted) to which the useful signal and the reference voltages are applied, as well as on the type of conductivity of the output transistor; this pulse is what starts up the digital measuring instruments or supplementary devices. Presence of a capacitor at the devices's input eliminated the effect of the useful signal's constant component. By

changing the reference voltage we can widely regulate the threshold at which the devices begin operating, which has great significance when synchronization involves extremely slowly changing signals, when a constant component is present, and when the noise level is high. The difference in voltage between the useful signal and reference voltage of the working comparator does not exceed 5 mv, and the input resistance consists of the rated value of the input resistor. The circuit of the simplest sort of cardiac pacemaker is shown in Figure 1a. Figure 1b shows the circuit of a synchronizer suggested for selective synchronization in relation to any biological signal chosen by the researcher. It is unique in that the power amplifier is represented by a transistorized "AND-NOT" matching circuit, owing to which pulses are shaped at the output only when a gating pulse of negative polarity is fed to input 2 from an external control device, or when pushbutton S1 is pressed on.

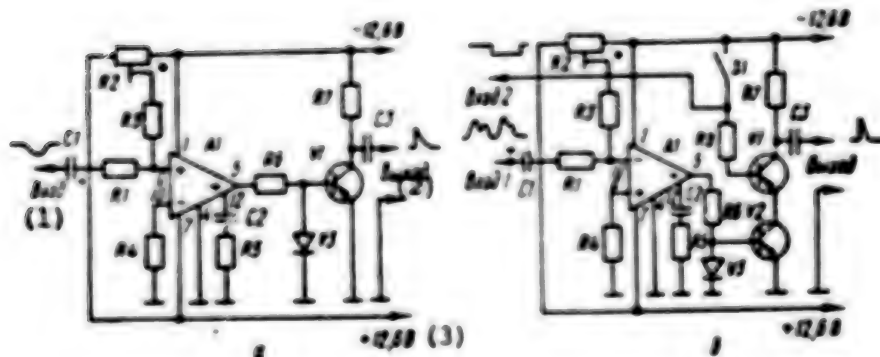


Figure 1. Built Synchronizer Circuits: a--Simple cardiac pacemaker; b--synchronizer permitting choice of synchronization periods: R1, R3, R4--100 kohms, R2, R6--10 kohms, R5--100 ohms, R6, R7--2 kohms, C1--10.0 μ f, C2--0.01 μ f, C3--0.1 μ f, A1--KIUT401B, V1, V2--MP42B, V3--D220

Key:

1. Input
2. Output
3. Volts

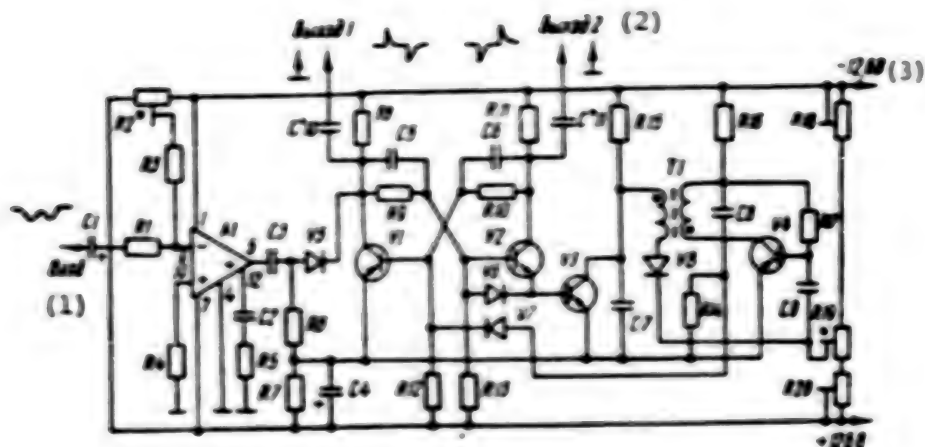


Figure 3. Circuit of a Synchronizer Controlling a Complex of Digital Measuring Instruments Intended for Semiautomatic Measurement of Rheogram Amplitude and Time Parameters:
 R1, R3, R4--100 kohms, R2, R6, R9, R10, R14, R19--10 kohms, R5--100 ohms, R7--560 ohms, R8, R11--2 kohms, R12, R13--20 kohms, R15--470 kohms, R16--2.4 kohms, R17--300 kohms, R18--15 kohms, R20--3 kohms, C1--10.0 μ f, C2--0.01 μ f, C3, C8, C9--0.1 μ f, C4--50.0 μ f, C5, C6--200 pf, C7--4.0 μ f, A1--K1UT401B, V1--4--MP42B, V5--8--D220, T1--GKh4.720.048 pulse transformer

Key:

1. Input
2. Output
3. Volts

Synchronization is based on the R spike on an electrocardiogram recorded synchronously with the rheogram. The pulse shaped in response to the R spike switches on a PP-9-1 counter (working like a stopwatch), which begins reckoning the time interval. The pulse from the output of the delay circuit, which is matched by the researcher with one of the typical points on the rheographic curve, stops the counter and simultaneously switches on a V7-16 digital voltmeter, which measures the amplitude of the rheogram at this point. At the same moment the rheogram is automatically calibrated by means of a supplementary device. Thus the amplitude and time parameters of the rheographic curve are measured in succession, point by point.

The synchronizers described here, all based on integrated microcircuits, have a simple design and possess high operating characteristics, to include high sensitivity and resistance to interference, high input resistance, a triggering threshold that remains stable and can be varied within wide limits, and economy.

The good design features of these devices make it possible to use them to synchronize the work of a broad range of physiological and measuring apparatus with various forms of biological signals; they can be used in special-purpose and general purpose complexes intended for diverse biomedical research.

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AN INSTRUMENT RECORDING SKIN ELECTRIC RESISTANCE

Kiev FIZIOLOGICHESKIY ZHURNAL in Russian No 1, 1979 pp 95-97

[Article by A. N. Lebed', V. P. Didenko, and A. V. Shumakov, Physics Department, Voroshilovgrad Medical Institute]

[Text] The method for recording the galvanic skin response is one of the objective methods for studying the state of the autonomic nervous system. There are two modifications of this method--recording skin electric potentials (Tarkhanov's modification) and recording skin electric resistance (Perre's modification). The two methods produce identical results. However, the apparatus required to record skin electric potentials is much more complex, and this is why the method involving measurement of skin electric resistance has enjoyed greater acceptance (3).

The galvanic skin response is a product of the activity of sweat glands, biological membrane permeability, skin hydrophilia, and blood supply. In this case skin electric resistance varies from several hundred to 100,000 ohms in places of the largest number of active, large sweat glands (on the palms of the hands or on the soles of the feet). Therefore we can use the results of analyzing skin electric resistance to assess reactions of the body's autonomic nervous system to the influence of various stimuli (painful sensations, psychoneural stress, light, sound, and so on).

Skin electric resistance is recorded by means of a device having a direct current bridge in its circuit (3). The shortcoming of such a bridge lies in the difficulty of balancing it, inasmuch as one of the arms contains the resistance being studied, which varies within broad limits. The instrument we developed does not have this shortcoming.

The skin electric resistance recording instrument, the basic diagram of which is shown in Figure 1, can record up to 50 percent of slow changes in skin resistance and up to 5 percent of fast changes. The recordings can be made on photographic oscillograph paper or on common magnetic tape followed by rerecording on paper. This instrument is a device consisting of a unit that

converts interelectrode resistance into equivalent voltage, a direct current amplifier, a master multivibrator, and a decoder. The instrument is powered by two KBSL-05 power cells.

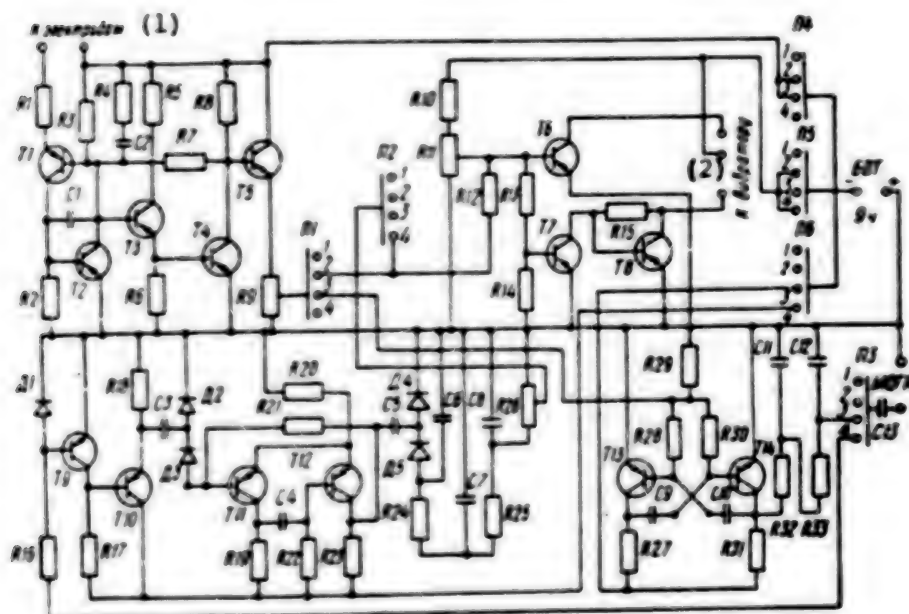


Figure 1. Basic Circuit of the Skin Electric Resistance Recording Instrument: R1--500 ohms; R2, R6--3 kohms; R3--20 kohms; R4, R8, R28, R30, R32, R33--8.2 kohms; R5--520 ohms; R7--1.0 Mohms; R9, R29--6.8 kohms; R10--150 kohms; R11, R14--15 kohms; R12--36 kohms; R13--2.4 kohms; R15--47 kohms; R16, R17--100 kohms; R18--10 kohms; R19--2 kohms; R20--180 ohms; R21--6.2 kohms; R22--27 kohms; R23--2.2 kohms; R24, R25--1.8 kohms; R26--1 kohm; R27, R31--3.6 kohms; C1--6,800 pf; C2--25 μ f; C3--0.1 μ f; C4--2,200 pf; C5, C13--5.0 μ f; C6, C7, C8--2.0 μ f; C9, C10--0.015 μ f; C11, C12--4,700 pf; T1--P 103; T2-T5--MP 41; T6-T8--MP 40; T9-T12--MP 42; T13, T14--P 16; Д1-Д3--D 101; Д4, Д5--D 226

Key:

1. To electrodes

2. To vibrator

We used a circuit without a bridge (1) to build the unit converting interelectrode resistance into equivalent voltage; although it does not possess a bridge, the circuit maintains constant sensitivity as resistance changes from several hundred ohms to 100 and more kohms. In this circuit, the

measured resistance (interelectrode) is connected to the circuit of transistor T1's emitter, the former performing the function of a self-tuning cascade (part of the output voltage is fed to the base of the transistor, changing its resistance). Inasmuch as the feedback circuit contains C2, which has a high blocking capacitance, it takes a long time for the mode to stabilize, and therefore the instrument has a time constant of not less than 10 sec.

The automatic mode tuning principle embodied in this circuit insures not only adjustable sensitivity but also maintenance of its operability in the presence of various destabilizing factors (change in temperature, slow reduction of power voltage, and so on).

The voltage equivalent to the interelectrode resistance is fed from the converter to the input of the direct current amplifier, which consists of transistors T6-T8. A 063-30 electromagnetic differential vibrator, which can be found in many medical recording devices, is used as the amplifier collector load. The output signal recording amplitude is adjusted by resistor R9, and the isoline is set with resistor R11.

When the research results must be recorded with a common tape recorder, operating mode switch II is moved to position 3; in this case voltage is fed from the converter to an FM acoustic frequency voltage oscillator--a symmetrical semiconductor multivibrator consisting of triodes T13 and T14. When the voltage from the converter changes by 1 volt, the frequency of the voltage generated changes linearly from 1,000 to 3,000 Hz.

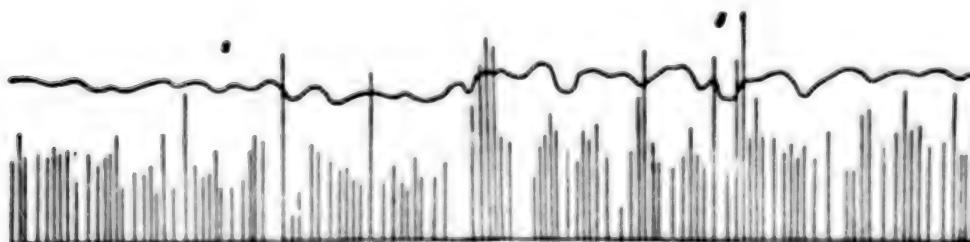


Figure 2. Recording Sample: *a*--At start of recording (1-2 min), *b*--at end of recording (14-15 min). Curve--skin electric resistance, vertical lines--reflex intervalogram (a recording of the times of responses to the stimulus)

The modulated voltage of the acoustic frequency oscillator is recorded on tape. Then, when necessary, the recorded information on interelectrode resistance is fed into the instrument and decoded, for which purpose the operating mode switch II is set at position 4. In this case the signal is fed from the tape recorder to a multivibrator frequency meter consisting of transistors T9-T12, and the voltage at its output is fed to the input of the direct

current amplifier. The recording amplitude is regulated in this case by means of resistor R26. Such a frequency meter is employed because the controlled multivibrator need not be stable during recording; all that is needed is for the characteristic curve to be linear within a broad range of frequencies.

Silver-plated electrodes applied to the skin and made from copper foil 0.5 mm thick in the form of discs with a diameter of 10 mm are used as the pickup unit. The place of application of the electrodes is processed with Nikoforov's mixture (a 1:1 ratio of alcohol and ether). The subelectrode linings (consisting of one layer of gauze) are saturated with electrode paste or shaving soap to which penicillin is added.

This skin electric resistance recording instrument was used together with a reflexintervalograph we developed earlier (2) to study the swiftness of reactions to a long-lasting experimental mental load; thus the curve on the recording sample shown in Figure 2 reflects the nature of change in skin resistance during the time of recording.

This recording shows that the amplitude of oscillations in skin electric resistance grows as mental fatigue develops. Considering that skin electric resistance rises when the tone of the sympathetic division of the autonomic nervous system dominates (owing to intensification of sweat gland activity) and that it increases when the tone of the parasympathetic division dominates, we can conclude that as mental fatigue develops, regulation of the tone of the sympathetic and parasympathetic divisions of the autonomic nervous system becomes less stable--that is, it worsens.

Tests on the instrument, performed with practically healthy people, showed that the resulting recordings are consistent and deserving of attention, and that the instrument is extremely simple to maintain, it works reliably, and it is not very sensitive to interference.

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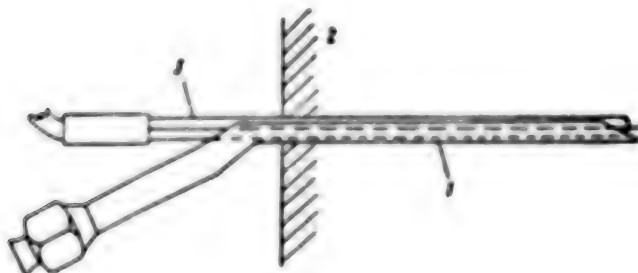
NEEDLE USED FOR INSERTION OF A GLASS-ENCLOSED PLATINUM ELECTRODE INTO BIOLOGICAL OBJECTS

Kiev FIZIOLOGICHESKIY ZHURNAL in Russian No 1, 1979 p 98

[Article by V. V. Koptukh and N. I. Get'man, Department of Pathological Physiology, Ternopol' Medical Institute]

[Text] A certain needle is used as an aid to insertion of a glass-enclosed platinum electrode when studying biological objects; it is a conventional injection needle and the electrode is passed through its opening. There are two methods that can be used with this needle to introduce a glass-enclosed platinum electrode into tissue to be studied.

In the first method the skin, the subcellular fatty tissue, and muscle are first punctured with the injection needle to the required depth, after which the needle is removed and the glass-enclosed platinum electrode is inserted through the resulting wound channel with a rotating motion. The shortcoming of this method is that after the needle is extracted the wound channel in the biological tissue loses its linearity to some extent, and subsequent insertion of the thin, fragile glass-enclosed platinum electrode carries the danger of its breakage; the latter means, first, the danger of leaving glass fragments in the biological tissue, second, premature wear of the platinum wire, and third, loss of time.



Principle of Needle Operation:
See text for explanation

In the second method the glass-enclosed platinum electrode is inserted into the opening of an injection needle previously introduced into the tissue to be studied; it is inserted to the point where it comes in contact with the biological tissue, thus making direct measurement of electrode depth possible. A significant shortcoming of this method is presence of two metals of different sorts in the tissue to be studied, which can result in generation of a voltage between them, which would contribute a significant error to the characteristics being measured (1). High-quality medical research requires safe, simple, and fast introduction of glass-enclosed platinum electrodes into biological objects. The needle we suggest for introducing the electrode has a bent S-shape (see Figure); its peripheral sharpened end (1) is cut in half in the shape of a trough.

A glass-enclosed platinum electrode is inserted into biological tissue with the help of the needle proposed here in the following way: The peripheral sharp end of the needle is inserted into the tissue to be studied (2) to the required depth, and the glass-enclosed platinum electrode (3) is inserted along the needle trough, after which the needle is removed from the tissue. This needle has a number of significant advantages: Longer life is insured for the fragile glass-enclosed platinum electrode, which results in a certain economic impact; safe, simple, and fast insertion of the glass-enclosed platinum electrode into the biological tissue to be studied; absence of another metal in the tissue at the time of measurement, which precludes the effect of voltages arising between different kinds of metals on the characteristics to be measured. The needle suggested here can be used in association with measurement of oxygen tension, oxidation-reduction potential, local blood flow rate based on hydrogen clearance, and so on.

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SANITATION

TECHNICAL ECONOMIC ASPECTS OF ORGANIZATION OF CLOSED SYSTEMS FOR INDUSTRIAL WATER SUPPLY

Moscow VODOSNABZHENIYE I SANITARNAYA TEKHNIKA in Russian No 5, 1979
pp 2-5

[Article by doctor of technical science S. V. Yakovlev, VNI Vodego [All-Union Scientific Research Institute of Water Supply, Canals, Hydro-technical Construction and Hydrogeological Engineering]]

[Text] The problems of conserving and, in some cases, improving the quality of water reservoirs in our country are being solved on a national scale. The solution to these problems involves development of new industrial technological processes and equipment which will insure maximum utilization and disposal of industrial wastes. The introduction of non-waste producing technology has almost completely solved the problem of protecting reservoirs from pollution. However, the development and introduction of non-waste producing technology requires time. At the present time, it is not yet possible to convert all industrial processes to non-waste producing technology. The task involves acceleration of plans to construct and introduce into national economic practice the principles of non-waste producing technology of the future. Potential use of a closed system for water supply in industrial activity plays an enormous role. Technology, used to construct a dependable water supply with minimum consumption of fresh water, is in widespread use. Simultaneously, rapid development of purifying installations to treat waste water has occurred. Recently constructed purification installations have helped to decrease the volume of unpurified wastes which, if left untreated, add to the process of river and lake pollution. These measures, however, are inadequate for sanitation of waste. Construction of purification installations with all their modern requirements cannot solve totally the problem of protecting reservoirs from pollution and depletion. The main pollutants present in water bodies will gradually increase because of the nature of industry. This fact necessitates the development of closed systems of water supply for industrial plants in which the disposal of waste water will be eliminated and fresh water will be used only to replenish supplies used for essential tasks. Experimental construction of such internal drainage for production has not yet been done in our country.

Basic efforts at the present time are directed at increasing the circulation of water in production by 80-90 percent, depending on the needs of various areas of production, and at constructing non-waste producing plants wherever it is economically feasible. The technical economic possibilities for and feasibility of construction of internal water circulating systems have already been demonstrated. Regional plans for purification and use of waste products from paper and pulp, chemical, automotive and petrochemical production have been formulated. The second stage of construction of the Pervomaiskiy chemical center has been implemented using a closed system for water supply. This system reduces the need for fresh water by 44 million m³ per year, decreases capital expenditure by 18 million rubles per year and increases commodity production by 4 million rubles per year. Scientific studies and plans for a closed system of water supply to the Tobol'skiy petrochemical complex have been completed.

Solution to the question of the economics of fresh water requires use of all the available and numerous resources in the economy. Economic indices for reservoirs differ significantly from those which characterize the percent of reservoir utilization by leading industrial enterprises. These relationships are characterized respectively by the following values: ferrous metallurgy--80 and 92 percent; chemical production--77 and 97 percent; paper and pulp production--52 and 75 percent; mining and chemical production--18 and 90-95 percent.

Undoubtedly the introduction of systems for reservoir conservation has, in a relatively short period of time, reduced significantly the consumption of fresh water in industry.

Waste water from industry must be purified, the extent of which is determined by technological requirements. On the whole, the extent of purification of waste water in a closed system is significantly less than that needed for waste water in open cisterns. Nevertheless, expenditures for purification of waste is still quite large necessitating improvement of the existing methods and development of new means to purify waste water. Work in this direction is being carried out at approximately 500 scientific research and advanced educational establishments and by more than 400 theoretical and design organizations in the country.

Plans for purification and the equipment which would be used for industrial waste water are very diverse and can be defined both by the qualitative and quantitative characteristics of the purified water and by the requirements in manufacture for the quality of the recycled water.

Plans for mechanical purification are present in all the proposals for purification of sewage. Attempts are made to increase the technological effectiveness of equipment while simultaneously decreasing their dimensions--an important criteria for the construction of non-waste producing systems for water supply in current industrial production. This

requirement is being satisfied by new multilevel sedimentation tanks, membrane filters, centrifuges, hydroextractors (pressure, non-pressure, multistage) and filters with new forms of mesh and load capacities. The use of these appliances has reduced the capital outlay by 3-5 times, and maintenance by 20-40 percent. The space needed to house this equipment has been reduced by 3-7 times in comparison to the space needed for standard sedimentation tanks. This reduced size allows proximity of purification equipment to the place where wastes are generated and where clean water is needed. This feature improves the economic indices of non-waste producing and closed circulation systems and decreases the loss of water through drainage and evaporation.

Methods for chemical and physical chemical purification of waste water are more widely used now. According to projected analyses, performed at the USSR MENIL Minvodkhoz [Moscow Electromechanical Scientific Research Laboratory of the Ministry of Reclamation and Water Management], the volumes of waste water which will be purified by these methods in 1990 will be increased in comparison with the amount purified in 1975 by 4.5 and 3.6 times respectively.

Organic flocculators are now widely used. These are highly effective and do not increase the salt content of the treated water--an important consideration for closed circulation systems. The flocculators form less sediments in relation to mineral coagulating agents. Electrodialysis, electrocoagulation and electroflotation are now widely used to remove from the waste water both soluble and non-soluble pollutants of an organic and mineral character. The main limitation of electrochemical methods of waste water purification which restricts their use is the relatively high output of electroenergy and sheet metal used in the production of the electrodes.

Sorption methods must be developed for purification of waste water. This entails discovery of new inexpensive natural sorbents for industrial wastes, the search for methods to increase the sorption capacity of existing sorbents and improvement of large volume apparatus. Ion-optical methods to purify waste water must be more widely used. This will allow utilization of valuable components extracted from the waste water and will decrease their mineralization.

One of the chemical means of purification involves use of powerful destructive oxides: ozone, chloride, hydrogen peroxide and chlorodioxide which can be used both independently and with other biochemical purifiers. As a result of the action of these strong oxides, the large molecules of organic, biochemically "hard," substances are destroyed. Thus, more simple compounds form which can be discharged in the process of biochemical purification. This method can lead to decrease in the cost of purification and does not cause an increase in the salt content in the water.

Biochemical methods at the present time play a substantial role in the purification of waste water. The volume of waste water purified by these methods will be significant in the near future.

Scientific research studies have been conducted to control and intensify the processes of biochemical purification and to develop new and improve existing installations according to improved technical economic indices.

Theoretical studies carried out in the past few years have led to the construction of apparatus in which intensity of biochemical processes is increased because of the generation of a large amount of active silt and use of commercial oxygen: oxytenka, phlototenka, and filtrottenka [words unknown]. The use of oxytenka for purification of waste water at a treatment station with a yield of 50,000 m³/day provides a yearly economic effect of about 250,000 rubles. The use of filtrottenka where the dose of silt can reach 9-25 g/l provides a yearly economic effect of 11,000 rubles for a waste purification plant with a yield of 150,000 m³/day. Flotation separation of silt mixtures produces a yearly economic effect of approximately 160,000 rubles for a plant with a yield of 30,000 m³/day for purification of petroleum-containing waste water. Investigations conducted recently showed the advantages of using stimulators (steroids, hormones) to accelerate the processes of biochemical purification of waste water.

Increase in the volume of purified water leads to the formation of large amounts of sediment. The tempo for introducing progressive methods of sediment treatment lags behind the tempo of developing technology for purification of waste water because of lack of government norms. Currently, there are many methods for concentration, stabilization, dehydration, dessication and heating of sediments but the basic direction in this field must be the elucidation and creation of the maximum possible utilization of the sediment. A maximum conservation effect is obtained by elimination of the sources of secondary contamination. Thus, the maximum economic effect is achieved.

At the Suoyarvskiy carton factory, organization of non-waste production and use of surplus active silt in the carton itself insures not only a decrease in the net cost for purification of waste but also a decrease in the net cost of production. It has been estimated that in carton production (280,000 tons of cartons per year) the construction of a non-waste water supply with simultaneous use of active silt insures a yearly economic effect of about 2.5 million rubles. At the Nikolayevskiy hydrolytic yeast plant recovery of purified wastes from production and use of surplus active silt from production of protein vitamin food products provide an economic effect of more than 500,000 rubles per year. Nonferrous metals are extracted from sediments of purified wastes at galvanizing factories making it possible to recover a sum of more than 30,000 rubles per year. Unfortunately, there are not many similar examples and in the majority of the cases the sediments after and without

treatment are placed in dumps creating the danger of secondary contamination of the natural environment. In order to solve this important and complex question of sediment utilization, which is absolutely essential for the creation of non-waste technology, and the purely technological questions (definition of requirements for the quality of utilized sediments, elucidation of potential consumption of one or another residues, etc.) it is necessary to solve a number of economic questions: evaluation of the economic effectiveness of utilizing sediments, elaboration of systems to stimulate their use.

The problem of stabilizing the salt content of water in circulating systems remains. Without a method to demineralize waste water the question of conversion to non-waste producing systems cannot be solved. Utilization of waste water at demineralization stations, lime softening of circulated water, creation of non-drain systems to help stabilize and inhibit water mineralization by reagents are directions which have been developed recently by specialists in various fields. Some results have already been achieved. Thus, at plants for nitrogen fertilizers introduction of closed circulation systems with stabilization of water in sodium bichromate provides a yearly economic effect of about 500,000 rubles. The economic effect from lime softening of waste water in circulating systems was 142,000 rubles. Studies have been conducted which show that in certain industries the salt content of recirculated water is stabilized quickly to acceptable levels removing any obstacle for conversion to a recirculated water supply system. The investment for introducing such a closed system of water supply was recouped in 2 to 3 years.

One method for demineralization of waste water is evaporation (concentration). This method is used for non-waste TES [Thermal Electrical Station]. The distillates obtained by this method are used for the needs of the electro-station and the dry salt is stored in preservatives for long-term conservation. The problem of treatment and utilization of mineral salts generated in a non-waste producing system has not been solved in many areas of the national economy. The comprehensive program of GKNT [USSR State Committee of Soviet Ministries for Science and Technology] for the creation and introduction of non-waste producing technology and industry includes a program to develop methods for utilization of salt wastes.

The construction of closed systems for water supply at industrial plants cannot be accomplished without solution to the problems of repeated use of waste water purified at standard industrial purification establishments. Unfortunately, there are few practical examples of such use of purified waste water. It is accomplished by creation of a group system of water supply for neighboring industrial plants and for irrigation of agricultural lands. On a local level, repeated use of biologically purified waste water has been developed for plants manufacturing paper and pulp.

The first stage of implementing this task is the creation of independent closed channels and selective repeated use of biologically purified sewage water thereby cutting by twofold water runoff. Future plans exist to introduce physical chemical methods of repurification which will provide a 3-4-fold decrease in the runoff of waste water. Furthermore, demineralization of 10-15 percent of waste water is insured by a non-waste system on a limited scale. Specialists consider a gradual conversion to construction and organization of closed water supply systems to be the most feasible form from a technical economic point of view.

For the construction of circulating non-waste producing systems of water supply, it is necessary to involve specialists from various scientific and industrial disciplines. Economic mathematical models can be constructed to optimize rational water consumption both for individual industrial plants and regional industrial areas whereby with a minimum of expenditure the question of use of water resources can be solved. Specialists study the dependence of expenditures on technological factors and find mathematical solutions for the problem of determining the economically expedient limits for use of circulating non-waste systems in specific industries. The creation of economic incentives which will stimulate the introduction of new technology for non-waste producing systems of water supply is central for the realization of rational supply systems.

Any progressive solution to the water supply problems of industry must consider the need to conserve water resources. Such water conserving functions must be evaluated economically. Many scientific investigative organizations are involved in the solution to this complex problem.

Frequently creation of water circulating systems for removal of contaminants causes an increase in the cost of purification which is not always offset by profit from use of the recovered products. Thus, for example, at one zinc factory, four water circulating systems for supply have been introduced whereby part of the water is removed from the system for desalinization. The residue after purification of the water is diverted to the factory for removal of metals. Calculation of the economic effect according to the established "methods for determination of the economic effectiveness of utilization of new technology in the national economy" showed unwarranted expenditures.

In recent years, designs for thermal energy without waste have been implemented. Specialists identified unwarranted large capital expenditures for construction of circulating systems in comparison with single pass boilers used at existing electrical stations. For example, in ferrous metallurgy the organization of water circulation which reduces the use of fresh water and the discharge of waste by 15-40-fold, is 2-2.3-fold more expensive than single pass water supply. Thus, the portion of reserves of water reaches 10-15 percent of the reserves of

basic industry. In these cases, it is especially important to develop optimal structures for water supply. Expenses for this should be evaluated not only from the point of view of compensation from additional output of the commercial product or utilization of residues but also with regard to relative depletion of water resources and the water conservation function of the particular measure.

The construction of non-waste producing systems provides a positive social, conservation and economic effect which is derived from:

1. Complete or partial prevention of economic loss caused by depletion of water resources because the need to organize transfer of water resources would no longer be necessary.
2. The positive effect from prevention or decrease of losses from contamination of the water surface:

In industry caused by previous wear of equipment which worsens the quality of the product and by increased costs for treatment of water;

In agriculture and the fishing industry caused by lowering of productivity and decline in the quality of the manufactured product because of utilization of contaminated natural water;

In communal life caused by increased expenditures for purification of contaminated natural water necessary for production of drinking water;

In the field of public health and social welfare caused by increase in morbidity which lowers the productivity of labor and the need to move recreation areas away from contaminated water bodies to a remote location. Thus, it is obvious that the economic effect of water conservation measures such as introduction of non-waste producing systems leads to prevention of losses from pollution and depletion of water resources. However, the absence at the present time of established and approved methods of calculating the complex loss complicates their utilization as criteria for economic evaluation of water conservation measures. In determining losses on the plant and national economic levels, the principles of unity must be observed. Calculation of the economic basis of different measures is very time-consuming and sometimes is not possible because of the absence of baseline information. In addition, the economic loss from pollution of water sources is determined by the limits of nongovernment financed activity at industrial plants and is not really reflected in the cost price of the basic product. Therefore, it is necessary to develop and verify methods for reduction of preventable economic loss based on differences in production costs of comparable products.

To simplify the economic evaluation of the cost of water conservation measures, standards should be developed to analyze the relative benefits

of eliminating the need to dispose of waste water. Such standards must be developed on the regional level. Incentives to develop water conservation measures must be introduced. These include scientifically based limitations on water consumption and differential fees for diversion of water from reservoirs and disposal of waste water.

Several areas of industry are in need of a unified method for economic evaluation of water circulating systems which would also consider ecological factors. Criteria must be established which would allow selection of methods with the maximum water conservation effect, the minimum expenditure for its implementation. These methods must be developed by the USSR Minvodkhoz [Ministry of Reclamation and Water Conservation] directed at areas of the national economy which consume the most water. Of unquestionable use would be the development and introduction of a bonus system and other forms of incentive for enterprises which introduce non-waste producing systems of water supply.

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TESTS AT BERDSK WATER SUPPLY LINE OF FILTERS LOADED WITH CRUSHED SCORCHED ROCK

Moscow VODOSNABZHENIYE I SANITARNAYA TEKHNIKA in Russian No 5, 1979
pp 25-26

[Article by engineer I. N. Samsonov (BerdsK water supply line), candidate of technical science A. M. Fominykh (Novosibirsk Engineering Construction Institute)]

[Text] Purification of drinking water at the BerdsK water supply line is conducted according to the following technological scheme: a purifier with suspended sediment serves as a quick method for filtration. In the summer, microfiltration is used to combat plankton. The projected productivity of the purification equipment is 12,000 m³/day. In the summer, the water supply source comes from the Berd' River. In the spring, the river floods quite rapidly. Transparency of the water at the source of the water supply during the flood period is reduced to 0 cm and turbidity reaches 200-500 mg/l. In the summer, transparency is 15-25 cm and turbidity is 10-40 mg/l.

From 1970-1971 because of the intense rate of industrial development in the city of BerdsK, acute deficits in the supply of drinking water for the population and industrial plants occurred. Questions on construction of a new complex for water purification equipment were discussed. However, the design and construction of the complex required time and the water was needed urgently by the city. The estimated costs for the project was 5 million rubles. The Novosibirsk Engineering Construction Institute was consulted whereby studies were conducted on new filtration material obtained from crushed scorched rock. Recommendations were provided for the fractionated composition of the filtration material and the technology for its manufacture. Scorched rock from the No 8 coal field in the city of Prokop'evsk was imported and the filtration material prepared. In 1970, four filters were loaded with the material and in the next year four more were filled. Thus, in the course of 2 years, reconstruction of the water supply line was implemented insuring intensification of the process of water purification by means of filtration. Productivity increased to 20,000 m³/day. The net cost for manufacturing

the filtration material, taking into account costs of transporting it from Kuzbass, was approximately 30 rubles/m³. The net cost of water purification was lowered by 40 percent. The total annual profit from utilization of purified water was increased by 65,500 rubles. The productivity of labor performed by the workers increased by 66.6 percent. The problem of raising the quality of purified water according to the requirements of GOST [Governmental All-Union Standards] 2874-73 was solved for work conditions.

In order to disseminate more widely use of the new filtration material made from the scorched rock in accordance with the instructions of the Main Administration for Water Supply and Canals of the RSFSR Ministry of Housing, the Siberian Section of the Republic Water Conservation and Canal Organization, experimental studies were conducted from May to August 1973 on filters loaded with crushed scorched rock at the Berdsk water supply line to obtain more complete data on the new filtration material as well as to compare parameters of filtration materials after 2 years of use. A second study of the filters at the Berdsk water supply line was conducted from May 1974 to August 1975.

In accordance with studies of the Republic Water Conservation and Canal Organization conducted in 1973 and 1975, the fractionated composition of the filtration material made from the scorched rock and the height of the rock load layer are characterized by the data in Table 1. By comparing parameters from 1973 and 1975 with initial parameters, it is obvious that essential changes did not occur in the fractionated composition of the rock load with use. Indices for mechanical stability of the filtration material selected from manufactured filters after 1-2 years of use were examined (Table 2).

Table 1

1. № фильтра	2. d ₁₀ , мм		3. d ₅₀ , мм		4. d ₈₀ , мм		5. d _{dek} , мм		6. k _n		7. Высота слоя загрузки, см	
	1973 г.	1975 г.	1973 г.	1975 г.	1973 г.	1975 г.	1973 г.	1975 г.	1973 г.	1975 г.	1973 г.	1975 г.
8. Исходный материал 1970 г.												
1	0.79		1.29		1.42		1.45		1.79			
2	0.91	0.88	1.21	1.32	1.56	1.64	1.36	1.26	1.72	2.41	11.5	10.1
3	0.89	0.8	1.28	1.34	1.5	1.67	1.39	1.3	1.65	2.09	10.6	10.6
4	0.81	1.05	1.26	1.5	2.02	2.05	1.44	1.52	2.91	1.9	10.6	10.6
5	0.89	1.02	1.24	1.41	1.81	1.82	1.39	1.57	2.07	1.79	10.4	10.2
6	0.71	0.8	1.06	1.24	1.27	1.6	1.05	1.1	1.79	2	10.6	10.6
7	0.66	0.82	1.09	1.3	1.29	1.67	1	1.16	1.9	2.66	10.7	10.2
8	0.66	0.8	1.1	1.24	1.16	1.31	1.09	1.19	2.22	1.96	10.1	10.1
9	0.8	0.95	1.1	1.34	1.41	1.6	1.12	1.46	1.56	1.67	10.7	10

Key:

- | | |
|-------------------------|----------------------------------|
| 1. Number of filter | 5. d _{dek} , мм |
| 2. d ₁₀ , мм | 6. k _n |
| 3. d ₅₀ , мм | 7. Height of rock load layer, cm |
| 4. d ₈₀ , мм | 8. Initial material, 1970 |

Table 2

1. Показатели	2. Номер фильтров		3. По нормам
	2	3	
4. Степень измельчения, %	0.1	0.68	1
5. Износостойкость, %	0.13	0.07	0.5

Key:

1. Indices
2. Number of filters
3. According to norms
4. Pulverization, percent
5. Wearability, percent

From the data presented in Table 2, it is evident that the indices for pulverization and wearability were significantly lower than the norms. After 7 years of filter use reloading or over-loading of filters was not necessary because the height of the rock load layer remained essentially unaltered, thus confirming the stable mechanical properties of the filtration material made from crushed scorched rock. Prior to 1976, washing of the filters was done in a rinsing tank with a capacity of 70 m³. Since 1976, washing has been done by a rinsing pump. During the flood period, rinsing is conducted 2-3 times a day in the course of 8-12 hours with an intensity of 12-15 l/cm² for 4.5-5 minutes. Using this regimen of rinsing, the growth of residual contamination in the load was not observed. Residual contamination in the filters did not exceed 0.45 percent with an acceptable norm of 1 percent (Table 3). The average discharge of rinse water during the flood period was 2-2.3 percent of the quantity of water purified.

Table 3

1. Номер фильтров	2. Остаточное загрязнение, %					
	27 V 1976 г.	6 VI 1974 г.	12 VI 1974 г.	2 VII 1974 г.	3 VIII 1974 г.	3 VIII 1974 г.
1	0.35	0.13	—	0.21	—	0.15
2	0.45	—	0.26	—	0.21	0.5

Key:

1. Number of the filter
2. Residual contamination, percent

Adequate revitalization of the load of scorched rock was confirmed also by the initial loss of pressure which did not change with time and had a linear relationship to the speed of filtration (Table 4).

Table 4

1. Филтровые и дата замеров	2. Параметры	3. Скорость фильтрации, м/ч								
		5	7.5	10	12.5	15	17.5	20	22.5	25
№ 2 13 VI 1974 г.	4. Потери напора, см	7.4	12.4	17.8	21.1	24	27.3	—	—	—
	5. Гидравлический уклон	0.06	0.1	0.15	0.17	0.2	0.23	—	—	—
	4. Потери напора, см	8.4	13.1	19.4	20.8	24	27.3	31	37.4	40.9
№ 5 13 VI 1974 г.	5. Гидравлический уклон	0.37	0.11	0.15	0.17	0.2	0.23	0.36	0.31	0.24
	4. Потери напора, см	—	—	12.7	19.9	25.3	28.1	30.4	—	—
	5. Гидравлический уклон	—	—	—	—	—	—	—	—	—

Note: Numerator--loss of pressure in 1974, denominator--in 1973.

Key:

1. Number of filter and date of survey
2. Parameters
3. Speed of filtration, m/hour
4. Loss of pressure, cm
5. Hydraulic gradient

The quality of the water after purification and the content of suspended residue in it during the most intense period of flooding are presented in Table 5.

Table 5

1.		2.		3.					4.	
Дата	Прозрачность в фильтрате, см	Прозрачность в фильтрате, см					Мутность для фильтрата, мг/л			
		№ 1	№ 2	№ 3	№ 4					
1 IV 1975 г.	8	6	6	6	6	6	0.5			
2 IV 1975 г.	4	27	26	26	26	26	—			
3 IV 1975 г.	1	20	20	20	20	20	—			
10 IV 1975 г.	0.5	25	25	25	25	25	0.4			
13 IV 1975 г.	0.5	30	30	30	30	30	0.4			
26 IV 1975 г.	0.5	25	30	30	30	30	0.4			
28 IV 1975 г.	0.5	30	30	30	30	30	0.22			
2 V 1975 г.	0.5	30	30	30	30	30	0.6			
7 V 1975 г.	0.5	30	30	30	30	30	0.1			
14 V 1975 г.	0.5	30	30	30	30	30	0.1			
22 V 1975 г.	1	30	30	30	30	30	0.11			

Key:

1. Date
2. Transparency of river water, cm
3. Transparency of water after clarification, cm
4. Turbidity of water (less than 25 mg/l)

Based on the data presented in Table 5, given a water transparency of 0.5-2 cm (according to the Snellen classification), the transparency of the water which passed through the filter was 16-30 cm, the content of

the suspended substance in it was 12-20 mg/l. Thus, it is obvious that the quality of the drinking water based on turbidity measurements corresponds to GOST 2874-73 on "Drinking Water." In the flood period, the average speed of filtration is 1516.5 m/hour, the duration of the filtration cycle is 8-12 hours, the muddiness of the load is 3.5-5.6 kg/m². These data point to the reliable protective effect of the filtration material made from scorched rock.

During the period of water purification by clarification of the residue suspended in it, a vacuum pressure gage with a measuring installation in the supply pipeline (pressure gradient on the curve) was set up in filter No 1. This allowed us to measure the maximum speed of filtration which was 20 m/hour with the quality of the water in relation to turbidity in accordance with GOST 2874-73.

Given mild turbidity of river water (less than 25 mg/l) in the summer period, the suspended residues in the purified water did not form. The filtration station works in the following manner: before the purification process water is coagulated with small amounts of coagulants (10-15 mg/l) and a polyacrilamide supplement (0.1 mg/l) after which a portion of the water--about 70 percent--is fed into the clarifier and the remaining portion goes directly into the filter. When untreated water with coagulants flows through the purifier light flakes of coagulated suspensions are formed and are retained in the filters. A portion of the untreated water with coagulants passes directly through the filter at which time the process of contact coagulation in the filter occurs. Using this method, purification of the water is conducted according to the parameters of GOST 2874-73 on "Drinking Water." With a turbidity of the river water of less than 10-15 mg/l coagulation is terminated. At this point, the clarifiers do not function and purification goes on only in the filters.

Conclusions

1. Filters, loaded with crushed scorched rock, work reliably without additional reloading or overloading of the filtration material. The speed of filtration is 18-20 m/hour insuring productivity of the purification equipment at the Berdsk water supply line on a level of from 12,000-20,000 m³/day. The net cost of water purification is reduced by 40 percent, the amount of annual profit increases to 65,500 rubles and the productivity of labor increases by 66.6 percent. Moreover, the quality of the purified water is raised to meet the requirements set by GOST 2874-73 for water used in work conditions.

2. The high level of muddiness in the filters (3.5-5.6 kg/m²) points to the reliable protective effect of the filtration material made from scorched rock.

3. Reconstruction of existing equipment for water purification by replacing the quartz sand with crushed scorched rock improves in a short period of time the productivity of the equipment by 1.5-2 times. The quality of the water is also improved and meets required standards.

4. To introduce this new filtration material in water supply lines throughout the USSR, it is necessary to organize industrial manufacture of filtration material made of scorched rock from the Kuznetsk coal field.

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SANITATION

TWELFTH INTERNATIONAL CONGRESS ON WATER SUPPLY

Moscow VODOSNABZHENIYE I SANITARNAYA TEKHNKA in Russian No 5, 1979
pp 30-31

[Source of article: economic information from the Informational Service of the Hungarian Commerce Bureau, Hungaro-press, 1978, No 20]

[Text] The Twelfth International Congress of Water Supply took place in Kyoto, Japan on 2-5 October 1978. More than 2,000 specialists from 51 countries took part in the meeting. The number of participants from each country varied: 1-3 representatives from Senegal, Seychelle Islands, Turkey, Syria, Afghanistan, etc.; 20-50 representatives from Australia, Belgium, Denmark, Federal Republic of Germany, etc.; and more than 100 representatives from Japan, France, Great Britain and the Netherlands.

The Soviet delegation participated in the congress in the sessions of the General Assembly of the International Association on Water Supply (MAV) and its various divisions (Administrative Committee and Scientific Technical Bureau).

During meetings of the various departments of MAV the following issues were resolved: selection of the president of MAV T. Ishibashi (Japan) and vice president Zh. Dezheni (France); a resolution to convene the next International Congress on Water Supply in France in 1980; and inclusion of the USSR delegation in the next meeting of the Administrative Committee, consisting of representatives from nine countries. Based on the suggestion of the Administrative Committee, the General Assembly resolved unanimously to award directorship of the Soviet delegation to F. A. Shevelev who was named corresponding member of MAV.

During the congress, 36 reports were presented and discussed:

General Reports

P. Gi (France): "Management of Water Resources";
P. Laburn: "Emergency Water Supply."

Reports on Special Topics

- R. Roman (Poland): "Analysis of Water Consumption";
S. Shubert (USSR): "Questions on Insuring the Quality of Drinking Water";
F. Fissinzhher (France): "Coagulation and Flocculation";
T. Zeybel (Great Britain): "Flotation";
M. Rapinat (France), Van der Kooy and V. Tsoyteman (Netherlands): "The Quality of Water in Distribution Systems";
M. Sago, Kh. Aua, F. Funaki (Japan): "Repeated Use and Recirculation of Water";
Ye. Koul (United States): "Loss of Water and Control of Leaking";
V. Gal'ves (Spain): "Modern Achievements in Planning and Production of Iron-Concrete Pipes";
G. Naber (Federal Republic of Germany): "Large Diameter Pipelines-- Problems of Deformation";
M. I. Shizuka, M. Takakhashi, Kh. Miamoto (Japan): "Large Diameter Pipelines";
Ye. Rid (Great Britain): "Reconstructing Old Pipelines";
A. Dzhonsen (Denmark): "Economic Questions Arising From the Exploitation of Water Supply Lines."

International Standing Committee on the Quality and Treatment of Water

- G. Myuller (Federal Republic of Germany): "Biological Compounds Which Generate After-tastes and Odors in Water; Their Significance and Composition";
A. Freyzer (Great Britain): "Automated Control of the Processes for Water Treatment";
U. Masshelyayn (Belgium): "Sanitary Characteristics of Reagents Used To Treat Drinking Water."

International Standing Committee on Problems of Distribution Networks

- T. Maykaoka (Japan): "Laying Pipelines in Difficult Conditions Including in Earthquake Zones";
V. Viynt'es (Netherlands): "Municipal Associations";
M. Roman (Poland): "Economic, Technical and Sanitary Aspects of Water Distribution Systems for Different Kinds of Water."

International Standing Committee on Protection of Water Sources From Contamination

- Zh. Bille, Zh. Pirson (France): "Use of Reservoirs for Protection of Surface Water From Accidental Pollution";
Kh. Fish, S. Torrenk (Great Britain): "Control of Industrial Pollution of Water Sources";
M. Shalekemp, P. Burkard (Switzerland): "Some Organic Contaminants of Surface Water and Transformation of Them."

International Standing Committee on Training and Specialization of Water Supply Line Personnel

- N. Mapuda (Japan): "Training for Personnel at Water Supply Lines in Japan";
P. Sherer (Federal Republic of Germany): "Training in Industrial Sanitation and Techniques of Safety at Water Supply Plants";
D. Khaykens (Netherlands), R. Turrel' (Great Britain): "Problems of Training Personnel To Construct Agricultural Systems of Water Supply in Developing Countries."

International Standing Committee on Questions of Corrosion and Protection of Underground Pipelines

- F. Frankvin (France): "Permeability of Concrete";
V. Kelle (Federal Republic of Germany): "Corrosion in Water Supply Systems";
R. Skimar (Belgium): "Corrosion of Prestressed Fittings";
S. Nago (Japan): "Protection of Underground Pipelines From Corrosion."

International Standing Committee on Water Meters and Measurement of Water Consumption

- A. Desmed (Belgium): "Advances in Water Meter Technology and Methods To Collect Fees for Water Consumption";
Zh. Bost (France): "Methods To Determine the Optimum Time To Replace Water Meters";
Kh. Shipmen (United States): "Policies for Calculating Water Consumption by Populations, in Particular in Developing Countries."

International Standing Committee on Desalinization

- A. Romeyn (Netherlands): "Evaporation Installations in the City of Ternezen (Netherlands)";
P. Trey (France): "A Desalinization Hyperfiltration Station in the City of El-Riyadh (Saudi Arabia)";
T. Sirotsu (Japan): "The State of Technology for Desalinization in Japan."

During the congress, the Soviet delegation was given a tour of the international exhibit, displaying models of water supply equipment. Approximately 84 exhibits were presented in 10 open areas. Japanese firms and certain foreign companies from Great Britain, France and the United States displayed their equipment.

The delegation visited two water supply stations in Tokyo. Methods for treatment of sediments at the Kanamachi water supply station was of interest. At the Arim water supply station, which was still under construction, an automated system to control the technological processes of

water treatment is being used. Computers monitor the treatment processes by telemetric control of the parameters of water purification in all the related equipment. The system is fitted with telemetric tools to control pH, turbidity, electroconductivity, chlorine and dosage of coagulants.

As a result of participation in the congress, the Soviet delegation became acquainted with the exhibitors displaying water supply equipment, visited water supply stations and gathered information on the newest achievements in the field of water supply. This information is of definite value for practical utilization of water supplies in the USSR. The most interesting material and suggestions of the congress will be published in a forthcoming collection entitled "Twelfth International Congress on Water Supply." Materials from the congress can be found in the scientific technical library of the AKKh [Academy of Municipal Services imeni K. D. Pamfilov].

A series of Hungarian reports on preservation of the environment, organized by the Hungarian Commerce Bureau and the Polish Internal Trade Bureau, were recently implemented for the first time in Poland. On 24-25 October 1978 in the Building of the Main Technical Organization (Federation of NTO [Scientific and Technical Society]) at Katovits, 10 reports were presented. Approximately 200 Polish specialists attended the meeting at which time policies to preserve the environment in the Hungarian People's Republic, types of fines for polluting the environment and arrangements to obtain subsidies from funds for environmental preservation were discussed. The specialists were familiarized with the industrial base for environmental preservation in Hungary and the variety of equipment and installations designed to implement measures for environmental preservation.

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SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

OBITUARY OF AKSEL' IVANOVICH BERG

Moscow PRAVDA in Russian 13 Jul 79 p 3

[Obituary by fellow scientists]

[Text] On July 9, 1979 Soviet science suffered a great loss with the death of Academician Aksel' Ivanovich Berg. The distinguished scientist and communist, prominent scientific organizer, Hero of Socialist Labor and retired admiral-engineer was 85.

An eminent scientist whose name is linked with the beginning of a whole series of new directions in science and technology is no longer with us.

Berg was born in the city of Orenburg on November 10, 1893. He completed naval college in 1914. During World War I Berg served as a submarine navigator. The Civil War saw him commanding a submarine of the Bolshevik Baltic Fleet. Berg's active scientific and pedagogical work unfolded following his graduation in 1925 from the Naval Academy in Leningrad.

Berg made major contributions to radio engineering and to the theory of radio transmitters and receivers. His advances in radio electronics were of great significance. Berg participated in the creation of a group of computer centers and scientific research radio electronics institutes. He served as the director of one of these--the USSR Academy of Sciences Institute of Radio Engineering and Electronics.

In 1946 Berg was made an active member of the USSR Academy of Sciences. As head of the Interdisciplinary Cybernetics Scientific Council under the Presidium of the Academy of Sciences USSR in 1959, Berg made major contributions to the development of this new and important field, including widening the application of electronics and computers to various sectors of the national economy.



The work of Academician Berg has been highly valued by both the Communist Party and the Soviet government. Berg, granted the title of Hero of Socialist Labor, was awarded four Orders of Lenin, the Order of the October Revolution, two Orders of the Red Banner, the Order of the Patriotic War (first degree), three Orders of the Red Star and many medals. The USSR Academy of Sciences awarded Berg the A. S. Popov Gold Medal.

Our fond memory of Aksel' Ivanovich Berg, outstanding scientist and loyal son of the Communist Party of the USSR who devoted his entire life to serving the Fatherland, will remain in our hearts forever.

[Signed by]

L. I. Brezhnev, V. V. Grishin, A. P. Kirilenko, A. N. Kosygin, M. A. Suslov,
D. F. Ustinov, K. U. Chernenko, M. V. Zimyanin, N. K. Baybakov,
V. A. Kirillin, L. V. Smirnov, A. P. Aleksandrov, S. P. Trapeznikov,
I. D. Serbin, P. S. Pleshakov, E. K. Pervyshin, A. I. Shokin,
V. A. Kotelnikov, B. N. Petrov, A. A. Logunov, YeP. Velikhov,
Yu. A. Ovchinnikov, P. N. Fedoseyev, G. I. Marchuk, G. K. Skryabin,
N. G. Basov, A. M. Prokhorov, M. S. Ryazanskiy, S. I. Samoylenko.

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SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

PROCEEDINGS OF THE 4TH INTERNATIONAL PARASITOLOGY CONGRESS

Moscow ZHURNAL OBSHCHEY BIOLOGII in Russian No 3, 1979 pp 478-479

[Article by Yu. I. Polyanskiy]

[Text] The 4th International Parasitology Congress (ICOPA IV) took place 19-26 August 1978 in Warsaw. The congress took place under the slogan "Mankind in a struggle with parasites."

More than 1,500 parasitologists from 84 countries took part in the work of the congress. Forty-eight people from the Soviet Union participated representing the USSR Academy of Sciences, the higher school, the Lenin All-Union Academy of Agricultural Sciences, and several other institutions and departments. Many representatives of the developing nations of Asia, Africa and South America took part in the work of the congress. This proved possible thanks to the significant material help shown by specialized organs of UNESCO.

At the beginning of the congress the theses of the reports presented were published in eight issues "Short Communications."

The basic work cells of the congress were composed of 31 workshops. Each workshop had a president, a deputy and a secretary who organized its work. They selected participants, led discussions, generalized material, etc. Each such workshop was devoted to one concrete question and met one time. The duration of its work was 3-3.5 hours. The themes of workshops were as follows: the morphology and taxonomy of helminths, the cytology and taxonomy of sporozoa, the cytology and taxonomy of parasitic flagellata, etc.

The workshops were united in eight sections. Section A was the biology, genetics and evolution of parasitic organisms; section B was the morphology and taxonomy of parasitic organisms; section C was parasitic infections having economic and social significance; section D was the therapy and prophylaxis of parasitic infections; section E was the immunology of parasitic infections; section F was the physiology of parasites and the pathophysiology of parasitic infections; section G was

the epidemiological problems of carriers and intermediate hosts; section H was spatial parasitology and geographical dissemination. From the names of the sections cited it is obvious that the problems of parasitology at the congress were considered widely and with many facets. President V. Mikhaylov (People's Republic of Bulgaria) in his introductory speech at the opening of the congress underlined the complex character of parasitology as a science and its close link with other biological sciences including with molecular biology, genetics, physiology, immunology and others.* At the same time parasitology has its own subject and methods of research and is not at all simply a conglomerate of individual parasitological disciplines such as protozoology, helminthology, arachno-entomology and others. At the congress two aspects of parasitology were clearly revealed. The first was its theoretical and general biological significance. In a number of problems of a theoretical order of general biological interest considered at the congress, one should name the evolution of parasite-host relationships and the problem of specificity, regularity of evolution, species formation and the problem of species in parasitic organisms, the problems of metabolism in parasites, the immunology of parasitic invasions. The development of the contemporary evolutionary theory is impossible to conceive without taking into account that qualitative peculiarity of the evolutionary process which parasites display.

The second aspect was the practical significance of parasitology and its role as the theoretical bases of the struggle with invasive illnesses. Several workshops were specifically devoted to individual parasitic infections--malaria, tripanisomiasis, leishmaniasis, and trichomoniasis, trichinosis, filariasis, echinococcosis, parasitic illnesses of fish and others. Much attention was devoted also to the biological basis of the prophylaxis and therapy of parasitic infections.

The work of the workshops devoted to a study of the mechanisms of the influence of various chemotherapeutic preparations on parasites and also of such specialized workshops as for example "The Therapy of Illnesses Elicited by Flatworms," "The Therapy of Invasions of Nematodes and Proboscidea Worms" was animated. The work of the workshop devoted to ecology (including stability to harmful factors) of those stages of parasites which exist in the external environment (eggs, larval stages, etc.) also had a practical bias.

A series of communications presented in various sections and workshops was devoted to the development of the teaching of Academician E. N. Pavlovskiy about the natural focal nature of transmitted illnesses. The work of the workshop, devoted to the study of the role of anthropurgic factors and of urbanization in the coming into being of host-parasite systems in anthropurgic centers was of great scientific and practical interest.

*The introductory speech of V. Mikhaylov is published in its entirety in the journal PARASITOLOGY, No 1, 1979.

One day was allotted for the meetings of "special groups" (there were 14 of them) devoted to individual, more particular questions. In their number was the consideration of individual systematic groups of parasites presenting special interest (for example, Monogenoidea from flatworms, Ceratopogonidae from two-winged insects) and other questions (for example, "The Nervous System in Parasites (Anatomy, Physiology, and Pharmacology)," "Parasitology Museums--Whose Should They Be?," "Parasitology Terminology," et al.). Many of these meetings were very animated and attracted a large number of participants.

The 24, 25 and 26 August plenary meetings of the congress took place, at which the leaders of all the workshops (grouped in sections) spoke with a short 15-minute account of the basic results of the group's work.

The scientific results of the congress deserve a high evaluation. It demonstrated the great progress of parasitology, showed its great theoretical and practical significance. The introduction of new progressive methods of research along a "wide front" was shown as was the close link of parasitology with other biological sciences. At the same time the congress allowed the realization and consideration of the paths of the further development of parasitology.

At the congress, which was organized by the International Federation of Parasitologists, by the Polish Academy of Sciences and by the Polish Parasitology Society, reelections to the Presidium of the International Federation of Parasitologists were carried out. The Polish parasitologist B. Chaplinski was chosen as president.

Meetings of the congress were held in the building of the Palace of Science and Culture. The participants of the congress warmly thanked their hosts for the excellent organization of this international forum, for their cordiality and hospitality.

It has been decided to hold the next congress in 1982 in Toronto, Canada.

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SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

PROCEEDINGS OF THE 17TH INTERNATIONAL ORNITHOLOGY CONGRESS

Moscow ZHURNAL OBSHCHEY BIOLOGII in Russian No 3, 1979 pp 479-480

[Article by N. V. Kokshayskiy]

[Text] The 17th International Ornithology Congress took place 4-11 June 1978 in East Berlin. The president of the congress was the American zoologist D. S. Farner, the general secretary was one of the directors of the East Berlin Zoo, R. Noehring. The work of the congress went on in the East Berlin "Congresshall" situated on the banks of the Spree in Tiergarten. The scientific program made provision for several plenary reports with one every day, numerous symposia (38 in all) on the most important questions of ornithology, meetings of "groups by interests" devoted either to discussions of problems raised in reports at symposia or to the consideration of independent questions.

About 400 specialists from 43 countries took part in the congress. The Soviet delegation consisted of four people. V. D. Il'ichev and N. V. Kokshayskiy from the USSR Academy of Sciences participated; they were invited to present reports at symposia. F. Ya. Dzerzhinskiy (Moscow State University) presented a demonstration on the biomechanics of a bird's skull. A. A. Vinokurov (USSR Ministry of Agriculture) participated in the meetings of the International Bird Banding Committee going on within the framework of the work of the congress.

The scientific program of the congress reflected the newest promising and intensively developing directions of ornithology. Works of the classical plane in general were either not examined or were considered in a very limited way. Thus descriptive morphology, subspecies taxonomy, faunistics were practically not presented; only a few questions from the province of applied ornithology and the protection of birds were examined.

The working day of the congress began with an hour plenary report. Two reports had a memorial character: K. Lorenz, Austria, about Oscar Heinroth, the founder of ethology; and E. Meyer, USA, about E. Stresemann and the development of his ideas in contemporary taxonomy of birds. J. Aschoff, FRG, made a report about biological clocks in birds;

D. Farner about the regulation of the yearly cycle in the white-crowned sparrow; W. T. Keeton, USA, about the contemporary state of the study of the orientation of birds; C. M. Perrins, England, about several questions of population ecology of birds.

The symposia, however, occupied the central place in the work of the congress. Their themes were clearly outlined, and one listened spell-bound to usually from 6-8 reports in each symposium. Four symposia and from two to three "interests groups" worked in parallel. Every day in the work of the congress provision was made for half-hour demonstrations as well as for the showing of scientific and scientific-popular films. In the evenings the meetings of the ornithological organizations went on, including the International Ornithological Committee (MOK) in which V. D. Il'ichev from the USSR participated. One day was assigned for carrying out local excursions.

The work of the symposia was concentrated around several basic trends. At the symposium for research on the phylogeny and adaptation of birds, several new facts on the paleontology of birds, new, mainly molecular, methods of taxonomy and the first results of their application were considered. At the symposium devoted to the aerodynamics and energetics of flight, N. V. Kokshayskiy made a report about the problem of the aerodynamic tracking of a flying bird and told about experiments carried out under his direction, for the first time allowing one to give a visual picture of the tracking. Significant attention at the symposium was devoted to the investigation of the flight of birds in aerodynamic tubes. Individual symposia were devoted to circulation and respiration, osmoregulation and thermoregulation of birds. Various aspects of biorhythmicity of birds were considered in detail.

V. D. Il'ichev presented a report at the symposium directed by him on the ecological physiology and morphology of birds' hearing. The report was devoted to the ecological approaches to the classification of the adaptation of the acoustic system of birds. At several symposia the vocalization of birds as well as the problem of their orientation was considered. The assumption about the possibility of birds using acoustic waves of subsonic frequency (right up to 0.05 Hz) for navigation stated in the report by M. L. Kreithen, USA, is interesting.

The problems of the symposia devoted to the ecology of birds were varied. Basic attention was concentrated on daily, seasonal, yearly energetic budgets of individuals; attempts were made to define the energetic cost of food obtaining activity, multiplication and molting in various species. Great attention was devoted also to the utilization of resources by birds, to the rivalrous relationships between them, to the structure of associations of birds and to changes of their composition in the course of large intervals of time. Reports at the symposia on the flock behavior of birds, the coevolution of birds and plants, the phenomena of "altruism" in birds and their evolutionary interpretation were rich in content.

Several organizational questions were examined. In conjunction with the partial renewal of the composition of the MOK, three new representatives from the USSR were coopted into it: V. R. Dol'nik, E. N. Kurochkin and V. E. Flint; V. D. Il'ichev was brought into the staff of the executive committee of MOK. At one of the meetings of MOK in accordance with an invitation transmitted by our delegation the decision was made to hold the next 18th International Ornithological Congress in 1982 in the Soviet Union. As president of this congress the well known Finnish ornithologist L. von Haartman was selected.

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